

## COURSE OUTLINE

### (1) GENERAL

<b>SCHOOL</b>	Engineering		
<b>ACADEMIC UNIT</b>	Mechanical Engineering		
<b>LEVEL OF STUDIES</b>	Undergraduate		
<b>COURSE CODE</b>	MY1400	<b>SEMESTER</b>	6 <sup>th</sup>
<b>COURSE TITLE</b>	Control Systems Engineering		
<b>INDEPENDENT TEACHING ACTIVITIES</b>	<b>WEEKLY TEACHING HOURS</b>	<b>CREDITS</b>	
<i>if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits</i>			
Lectures and coursework	5	6	
<i>Add rows if necessary. The organisation of teaching and the methods used are described in detail at (d).</i>			
<b>COURSE TYPE</b>			
<i>general background, special background, specialized general knowledge, skills development</i>	Background		
<b>PREREQUISITE COURSES:</b>	-		
<b>LANGUAGE OF INSTRUCTION and EXAMINATIONS:</b>	Greek or English		
<b>IS THE COURSE OFFERED TO ERASMUS STUDENTS</b>	Yes (tutoring)		
<b>COURSE WEBSITE (URL)</b>	<a href="https://www.mie.uth.gr/?page_id=17915">https://www.mie.uth.gr/?page_id=17915</a>		

### (2) LEARNING OUTCOMES

<p><b>Learning outcomes</b></p> <p><i>The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.</i></p> <p><i>Consult Appendix A</i></p> <ul style="list-style-type: none"> <li>• <i>Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area</i></li> <li>• <i>Descriptors for Levels 6, 7 &amp; 8 of the European Qualifications Framework for Lifelong Learning and Appendix B</i></li> <li>• <i>Guidelines for writing Learning Outcomes</i></li> </ul>
<p>This course will introduce students to the fundamentals of dynamical systems and automatic control, focusing on the analysis and design of control systems using classical control theory. Emphasis is given on the controller design for single input-single output systems with applications to electrical, hydraulic, and mechanical systems.</p> <p>By the end of this course students will be able to:</p> <ul style="list-style-type: none"> <li>• Define basic concepts in the area of automatic control.</li> <li>• Transform mathematical models of linear dynamic systems between time domain input/output form, transfer function form, and state-space form.</li> <li>• Analyse models of linear dynamic systems that are given in the forms above with respect to stability, pole placement, rise time, damping, controllability and observability.</li> <li>• Perform stability analysis of feedback control systems using Bode and Nyquist diagrams.</li> <li>• Perform stability analysis of feedback control systems using the root locus method.</li> <li>• Design controllers in PID-form, lead-lag form, and feedforward form based on given specifications.</li> </ul>

### General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	Project planning and management
Adapting to new situations	Respect for difference and multiculturalism
Decision-making	Respect for the natural environment
Working independently	Showing social, professional and ethical responsibility and sensitivity to gender issues
Team work	Criticism and self-criticism
Working in an international environment	Production of free, creative and inductive
thinking Working in an interdisciplinary environment	.....
Production of new research ideas	Others...
	.....

- Search for, analysis and synthesis of data and information with the use of the necessary technology
- Decision making
- Working independently
- Team work
- Application of theory to practice
- Production of new research ideas
- Project planning and management

### (3) SYLLABUS

1. Introduction to automatic control systems (history and applications)
2. Mathematical modelling of dynamical systems
  - a. Different types of systems, modelling (state-space description) and normalization
  - b. The presence of disturbances and role of feedback, sensors and actuators
  - c. Examples: mechanical, thermal, hydraulic, electrical
  - d. Linearisation of non-linear systems
3. System Analysis: Time domain
  - a. System response for first and second order systems
  - b. Stability of linear systems
  - c. Controllability and observability
4. System Analysis: Frequency domain
  - a. Laplace transform I, transfer functions, analytical solution
  - b. Laplace transform II, poles and zeros, BIBO stability
  - c. Frequency response: Bode and Nyquist diagrams
  - d. Stability: Bode and Nyquist criteria
  - e. Stability: Routh-Hurwitz algebraic criterion
  - f. Stability: Root-locus criterion
5. Feedback control systems
  - a. Closed-loop control – idea of feedback
  - b. Performance criteria
  - c. Specification of the desired closed-loop system behaviour
6. Controller design
  - a. Specifications
  - b. Controller design via root locus
  - c. P, PI, PD, PID controllers
  - d. Controller design of PID via “loop shaping”
  - e. Feedforward compensation, cascade control

#### (4) TEACHING and LEARNING METHODS - EVALUATION

<b>DELIVERY</b> <i>Face-to-face, Distance learning, etc.</i>	Face-to-face	
<b>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY</b> <i>Use of ICT in teaching, laboratory education, communication with students</i>	<ul style="list-style-type: none"> <li>• Use of Simulink (Matlab) for the simulation and analysis of control systems</li> <li>• Use of the “Control Toolbox” (Matlab) for controller design</li> <li>• Use of internet for notes and additional material on control systems</li> <li>• Communication with students via the eclass platform</li> </ul>	
<b>TEACHING METHODS</b> <i>The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.</i>  <i>The student's study hours for each learning activity are given as well as the hours of non- directed study according to the principles of the ECTS</i>	<i>Activity</i>	<i>Semester workload</i>
	Lectures	40
	Tutorials	12
	Laboratory work	6
	Coursework/Project work (at home)	42
	Private study	50
	Course total	150
<b>STUDENT PERFORMANCE EVALUATION</b>  <i>Description of the evaluation procedure</i>  <i>Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open- ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other</i>  <i>Specifically-defined evaluation criteria are given, and if and where they are accessible to students.</i>	<ul style="list-style-type: none"> <li>• Language of evaluation: Greek (or English)</li> <li>• Assessment: <ul style="list-style-type: none"> <li>○ Examination (70%)</li> <li>○ Coursework and/or laboratory work (30%)</li> </ul> </li> </ul> <p>Description of Coursework and/or laboratory work</p> <ul style="list-style-type: none"> <li>• Coursework: 6 sets of exercises and/or</li> <li>• 1-2 laboratory assignments or small project on the application of automatic control to real life problems (students can work in teams)</li> </ul>	

#### (5) ATTACHED BIBLIOGRAPHY

##### *-Suggested bibliography:*

##### **Greek:**

- Κρικέλης, Ν. Ι., Εισαγωγή στον Αυτόματο Έλεγχο, Εκδόσεις Συμμετρία, 2002. (Εύδοξος: 45290)
- Nise Ν. S., Συστήματα Αυτομάτου Ελέγχου, 7<sup>η</sup> Έκδοση, Εκδόσεις Fountas, 2016. (Εύδοξος: 59380555)
- Ogata, K., Συστήματα Αυτομάτου Ελέγχου, 5<sup>η</sup> Έκδοση, Εκδόσεις Fountas, 2011. (Εύδοξος: 12346979)
- Dorf R. C., Bishop R. H., Σύγχρονα συστήματα αυτόματου ελέγχου, 13<sup>η</sup> Έκδοση, Εκδόσεις Τζιόλα. (Εύδοξος: 59396181)
- Κuo Β., Golnaraghi F., Συστήματα Αυτομάτου Ελέγχου, 1<sup>η</sup> Έκδοση, Εκδόσεις Ιων, 2010. (Εύδοξος: 42798)
- DiStefano J. J., Stubberud A. R., Williams I. J., “Θεωρία και προβλήματα στα συστήματα αυτομάτου ελέγχου αναλογικών και ψηφιακών συστημάτων”, 2η Έκδοση, Εκδόσεις Τζιόλα
- Μαλατέστας Π. Β., Συστήματα Αυτομάτου Ελέγχου, 2<sup>η</sup> Έκδοση, Εκδόσεις Τζιόλα, 2017 (Εύδοξος: 68369734)

**English:**

- Nise N. S., Control Systems Engineering, 7<sup>th</sup> Edition, Wiley, 2015.
- Franklin, G. F., Powell, J. D., Emami-Naeini, A., Feedback Control of Dynamic Systems. 8<sup>th</sup> Edition, Pearson, 2019
- Dorf R.C., Bishop R.H., "Modern Control Systems", 12th Edition, Prentice Hall
- Ogata, K., Modern Control Engineering, 5<sup>th</sup> Edition, Prentice-Hall, 2011.
- Golnaraghi F., Kuo B.C., Automatic Control Systems, 10<sup>th</sup> Edition, McGraw-Hill, 2017.
- D'Azzo J.J, Houpis C.H., "Linear Control System Analysis And Design: Conventional and Modern", 4th Edition, McGraw-Hill
- Stubberud A., Williams I., DiStefano J., "Schaum's Outline of Feedback and Control Systems", 2nd Edition, McGraw-Hill

**- Related academic journals:**

- *Automatica*
- *Control Engineering Practice*
- *IEEE Transactions on Automatic Control*
- *IEEE Transactions on Control of Network Systems*
- *IEEE Transactions on Control Systems Technology*
- *IET Control Theory and Applications*
- *International Journal of Control*
- *International Journal of Robust and Nonlinear Control*
- *Systems and Control Letters*