COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Science		
ACADEMIC UNIT	Physics		
LEVEL OF STUDIES	Undergraduate (graduate course offered to undergraduate students)		
COURSE CODE	**10EK211**	**SEMESTER**	**8**
COURSE TITLE	**Automatic Control Systems**		

INDEPENDENT TEACHING ACTIVITIES *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*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures (theory and exercises)	3	6
laboratory exercises	1	

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialised knowledge
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes, in the English language for Erasmus students
COURSE WEBSITE (URL)	https://eclass.uoa.gr/courses/PHYS241/

(2) LEARNING OUTCOMES

Learning outcomes

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.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

In Physical Education, and especially in the case of electronics, automated control courses can help to change the view of the physical system itself.

The concept of feedback is critical and meaningful in order to understand the way in which a natural system changes. It can help broaden the theoretical background of a theoretical physics while it is a necessary knowledge for an experimental physicist.

At the same time, automatic control systems are essential, basic knowledge for the specialization of electronics, as a large part of elementary electronic devices, telecommunication devices, etc., are based on feedback systems.

Modeling with automatic control methodologies, such as Laplace transformation techniques and determining the corresponding transfer functions, is the first step in describing and studying systems. Then the analysis with the state space equations (in the time domain and in the frequency domain) leads to the proper design of the appropriate automatic controllers for example to accelerate / slow down the evolution of the systems, as well as to determine and control their physical limits.

All of the above highlights a number of important tools for the design and execution of experimental processes as well as theoretical studies. In particular, closed loop and feedback systems play a catalytic role in complex systems encountered in electronic applications, such as analog and digital circuits and devices, in astronomy, such as adaptive optics, in Nuclear Physics, such as magnetic fusion restriction, in specific modes of operation of laboratory instruments (Atomic Force Microscopy), but also in neighboring disciplines such as Biology.

Furthermore, understanding the theory of linear control systems is important for approaching situations requiring automatic control tools and methodologies in physics science, such as quantum control (e.g. coherent control).

The course also includes a presentation of modern methodologies for the design of automatic control systems using co-development computational tools (Google Colab, Jupyter Notebook)

Individual objectives of the course - expected learning outcomes:

After completing the course the students are expected to:

1. Understand the basic features of the feedback concept and how it affects a linear dynamic system.
2. Describe the basic parts of a linear system using flow charts and the corresponding terminology.
3. Lay out the appropriate differential equations for a continuous time system.
4. Use methodologies and corresponding mathematical techniques for modeling the above systems (Laplace transforms and inverse transformations).
5. Form the transfer functions, feedback and error functions in electrical, mechanical and electronic systems.
6. Use and apply conversion from the time domain to the frequency domain and vice versa.
7. Solve a time invariant linear system (LTI) in the time and frequency domains.
8. To conclude about the stability of a system with single input and single output (SISO).
9. Design and interpret Nyquist diagrams.
10. Design and interpret Bode diagrams.
11. Plan ahead and phase delay controllers.
12. Lay out the appropriate state space equations for a discrete time system.
13. Use methodologies and corresponding mathematical techniques for modeling the above systems (z transforms and inverse transformations).
14. Conclude on the stability of a discrete time system.

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…*
	…….

The course aims at the following general competences

Search for, analysis and synthesis of data and information, with the use of the necessary technology
Adapting to new situations
Decision-making
Working independently / Team work
Working in an international environment / Working in an interdisciplinary environment
Production of new research ideas / Project planning and management
Production of free, creative and inductive thinking
Analytical and synthetic thinking /Critical thinking
Time management / Planning
Taking initiative/responsibility
New Technology skills
Learning Python programming language
Creativity/ Determination /Information management
Flexibility / Adaptability / Problem solving

(3) SYLLABUS

- Basic concepts, Laplace and inverse Laplace transform, applications.
- Transfer function (of complex frequency), feedback, steady state errors.
- State equations (electrical, mechanical, electronic systems).
- Matrices, matrix exponential, solution of LTI systems in frequency and time domain.
- Stability (SISO open and closed loop systems systems)
- Routh–Hurwitz stability criterion, root locus analysis
- Bode plots, phase lag and lead networks and design.
- Discrete time systems, Z-transform, inverse Z, stability.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Yes Electronic communication with the students using ICT (Information and Communications Technology) Computer-aided lectures, use of Overhead Projectors, eclass platform
TEACHING METHODS *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.* *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*	(see table below)

Activity	Semester workload
Lectures	39
Lab Exercises in python using Python -control toolbox and co-development programming tools (Jupyter notebook)	13
Individual Study/ Study and Analysis of bibliography / Preparation	98
Course Total	**150**

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *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* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	50% Written exams 30% 10 lab exercises in python using python control toolbox 20% Final project theoretical/computational analysis of an automatic control problem

(5) ATTACHED BIBLIOGRAPHY

Suggested bibliography

- Ogata, K., Modern Control Engineering, 2009 (Εύδοξος: 12346979).
- Dorf R.C., Bishop R.H., Modern Control Systems, 2003, (Εύδοξος: 59396181)
- Krikelis, N.I., Introduction to Automatic Control, 2002 (Εύδοξος: 45290).
- Karl J. Åström and Richard M. Murray, Feedback Systems: An Introduction for Scientists and Engineers (ISBN: 9780691193984, Princeton University Press)

- Related academic journals:

- IEEE Robotics & Automation Magazine
- IEEE Spectrum: Technology, Engineering, and Science News

- Computational tools

- Python Control Systems Library (python-control) (Richard M. Murray) https://python-control.readthedocs.io/