COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF ELECTRONICS ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	2606002	**SEMESTER**	6
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 (ECTS)**
Lectures	4	7
Laboratory	2	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Specialisation Course
PREREQUISITE COURSES:	None
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES (in English)
COURSE WEBSITE (URL)	http://rangoussi.teipir.gr & http://labpower.teipir.gr/index_hl.htm

(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*

Upon successful completion of this course module students possess advanced knowledge, skills and competences in the subject of Automatic Control Systems that enable them to:

1. Describe all basic ACS structures by block diagrams.
2. Translate readily a time-domain ACS description into a frequency-domain one and vice-versa; select the appropriate and simpler possible form for the problem at hand.
3. Use software system simulation tools to compute the ACS output in the time and in the frequency domains. Assess the quality of the output with respect to given specifications and estimate the error between actual and desired output.
4. State and apply the algebraic and the graphics ACS stability criteria, simulate each criterion in software, interpret the results; assess and characterize an ACS using the results and thus

perform a full ACS stability study.

5. Analyze a realistic problem that requires controller / compensator design, judge and select the appropriate among alternative controller architectures taught in the course; design the controller in block diagram level and simulate the ACS including the controller in software.
6. Collaborate with fellow students in a team, in order to thoroughly address complex controller design problems (analysis – synthesis) under realistic conditions and to critically evaluate alternative solutions, leading to decisions as to the feasibility of hardware implementations.

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
- Working independently
- Team work
- Production of free, creative and inductive thinking

(3) COURSE CONTENT

<u>Lectures</u>

UNIT I: Introduction to closed-loop systems and block diagram simplification

1. Open- and closed-loop systems, Feedback (positive and negative), Impulse Response and Transfer function descriptions of Linear Systems, Transfer function extraction examples.
2. Block diagrams; simplification of a block diagram into a simpler equivalent one using equivalence rules. Generalization from 1-by-1 to M-by-N I/O systems.

UNIT II: Time domain response of 1st and 2nd order systems – Errors in the Steady-state.

1. Computation of the time response of 1st and 2nd order systems for basic input waveforms (sinusoidal, step, ramp, parabolic).
2. Error signal definition, Limiting value theorem, Error constants and steady-state error computation for polynomial inputs.

UNIT III: Closed-loop system stability – Definitions and Criteria - Algebraic (Routh) and graphics (Root Locus).

1. Linear system stability: Definitions and Criteria (algebraic – graphics).
2. The Routh Criterion and its parametric forms. Conditional stability.
3. Root locus – Drawing, interpretation, ACS characterization, complete 1-by-1 ACS stability study.

UNIT IV Bode, Nyquist, Nichols Diagrams and Gain / Phase Margins.

1. Bode diagram: Drawing, interpretation, stability study using the associated criterion. Definition, meaning and uses of gain and phase margins in conjunction with the Bode diagram.
2. Nyquist and Nichols diagrams and associated stability criteria. Critical frequency, Niquist point.

UNIT V: System compensation and controller design – general principles. PID controllers and parameter setting.

1. Introduction to the system compensation, aims and controller types. Series and parallel controllers.
2. PID controllers – applications and parameter setting (Ziegler-Nichols empirical rules).

UNIT VI: Phase lead / lag controllers and hybrid solutions.

1. Phase lead / lag controller design for series compensation. Applications on the basis of given specs and software simulation.
2. Parallel system compensation (velocity, acceleration). Comparative assessment of series and parallel design solutions.

Laboratory

1. Time response of 1^{st} and 2^{nd} order linear systems.
2. Frequency domain response and frequency plots (Bode, Nyquist, Nichols Diagrams).
3. Steady-state Errors in the ACS output.
4. PID controllers.
5. Velocity control ACS (hands-on plus computer simulation, accessed remotely).
6. Liquid level control ACS (hands-on plus computer simulation, accessed remotely).
7. Position Control ACS.
8. Sinusoidal waveform generation – 2^{nd} order ACS (PLL).
9. Programmable Logic Controllers (PLCs).
10. Telemetric Systems based on GSM modem.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face to face lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of electronic presentation with multimedia content in class, • Student support through the course webpage and the departmental e-learning platform, • Electronic communication of instructors and students, through the course webpage and by e-mail. • Simulation software for the simulation study and stability study of ACS, in the lectures part of the course. • Virtual Lab through the use of simulation software for the simulation study of ACS, for telemetric / telecontrol applications and for remote realization of experiments

	(Remote Lab), in the lab part of the course.
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*	Lectures, Laboratory experiments, project (optional), study.

Activity	***Semester workload (hours)***
Lectures	52
Study for lectures	52
Laboratory experiments	26
Report on lab experiments – group or personal	26
Personal or group project related to lecture material	26
Study and preparation for exams	28
Course Total	***210***

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.

Final course grade =

Lectures part grade x 60% + Laboratory part grade x 40%, analyzed as follows:

<u>Lectures part grade:</u>

Midterm Exam –2 hours (30%)

Final written exam – 2 hours (70%)

Optional personal or group project up to 20%, final exam reduced to 50%.

Final written exam covers all taught material. During the exam, students may consult a list of formulae provided by the examiner as a reminder. Students must prove mastery of the material through stating and interpreting definitions of all quantities, handling relations among quantities and solving of design problems based on specs.

<u>Laboratory part grade:</u>

Lab part grade is the average of all (10) individual Lab Experiment Grades achieved by the student during the semester.

Lab Experiment Grade = Oral exam in class (60%) plus written test in class (40%), on the subject of the current Experiment.

A written preparatory homework is assigned each week, on the subject of the Experiment scheduled for next week.

(5) ATTACHED BIBLIOGRAPHY

<u>Essential reading</u>

1. DORF, R.C., BISHOP, R.H., Modern Control Systems, Prentice-Hall, 2000.
2. SCHAUMS's Outline Series on Feedback and Control Systems, 2^{nd} Ed., McGraw-Hill Professional Publishing.
3. Laboratory notes by laboratory instructor: http://labpower.teipir.gr/index.htm

Recommended Books

1. CHEN, C.-T., Linear System Theory and Design, HRW, 1981.
2. OGATA, K., Modern Control Engineering, Prentice Hall Inc., New Jersey, 1997.
3. KUO, B.C., Automatic Control Systems, Prentice-Hall Inc., New Jersey, 1995.
4. KAILATH, TH., Linear System Theory, Prentice-Hall, 1980.