AEEE541 - Modern Control Systems

Course Title	Modern Control Systems				
Course Code	AEEE541				
Course Type	Compulsory				
Level	MSc (Level 2)				
Year / Semester	1 / 2				
Teacher's Name	Dr Marios Lestas, Prof Christos Themistos				
ECTS	8	Lectures / week	3	Laboratories / week	
Course Purpose and Objectives	The aim of the course is to familiarize students with the concepts and the principles underlying the field of Modern Control Systems, to provide the students with deep knowledge of the theories and methodologies related to the determination of the characteristics of Control Systems and their response to the action of several input signals and to enable students develop the skills required to perform Stability analysis and design suitable Controllers to maintain Stability.				
Learning Outcomes	By the end of the course, students must be able to: 1. Review the static characteristics of a control system and interprete the meaning of the open- and closed-loop transfer function concepts in the block diagram representation of engineering control systems. 2. Derive the mathematical model of basic electrical, mechanical and hydraulic control systems. Obtain experimentally the plant parameters of classical spring-mass control systems, by measuring indirectly the mass, spring, and damping parameters 3. Examine the action of aperiodic Signals in the Transient-Response Analysis of First-, Second- and Higher-Order Control Systems. Implement experimentally Transient Response Analysis of First- and Second-Order classical Control spring-mass Systems 4. Examine the action of the Proportional, Integral and Derivative Controllers on the static and transient characteristics of Control Systems. Model the effects of basic controllers on classical spring-mass systems via data acquisition techniques and simulate their action using MATLAB/ Simulink software. 5. Interprete the meaning of stability of control systems in terms of the transfer function and judge the stability of a closed-loop control system from the Routh-Hurwitch Criteria. Judge the performance of three distinct controller designs in rejecting low and higher frequency disturbances. 6. Draw Bode and Nyquist Plots Plots and judge the stability of a control system using the Phase and Gain margin in criteria in frequency domain plots 7. Review matrix algebra, eigenvalues and eigenvectors, State variables,				

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<tr><td></td><td colspan="3">State-space equations.
8. Realise State space transfer functions, Canonical forms, and Transformation of system models.
9. Understand the State space models, Feedback Controller Design and Optimal Control of dynamic control systems
10. Solve the linear time-invariant state equations and compute the state-transition matrix of linear time-invariant control systems
11. Understand the non-linear system properties and characteristics and apply linearization of non-linear systems.
12. Apply Lyaponov stability analysis techniques for non-linear systems</td></tr>
<tr><td>Prerequisites</td><td>None</td><td>Required</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="3">• Review of Classical Control Theory: Laplace Transform, Open-loop, closed loop control systems, Transfer function, Dynamic Systems
• Mathematical Modelling of Dynamical Control Systems Block Diagrams. Signal-Flow Graphs. Modelling in State Space. Electrical and Mechanical Systems
• Transient-Response Analysis Aperiodic Signals. First-Order Systems. Second-Order Systems. Higher-Order Systems.
• Control Actions and Response of Control Systems: Proportional, Integral and Derivative Control Actions. Effects of Control Actions on System’s Performance.
• Stability of Control Systems Ruth-Hurwitz Stability Criterion. Steady-State Errors in Control Systems.
• Frequency Domain Approach Bode Plots, Phase and Gain margin. Nyquist Plots and Nyquist Stability.
• Introduction to state space analysis: Review matrix algebra, eigenvalues and eigenvectors, State variables, State-space equations,
• Linear time-invariant systems: linear time-invariant state equations, State-transition matrix of linear time-invariant control systems
• Lyaponov stability analysis: Non-linear systems, First and second methods of Lyaponov. Stability analysis of non-linear systems, stability analysis.
<u>Laboratory Demonstration</u>
• Plant parameter identification for Linear / Tortional (ECP) Control Systems
• Rigid Body PD & PID Control of Linear / Tortional (ECP) Control Systems
• Disturbance Rejection of Various 1 DOF Plant Controllers on Tortional (ECP) Control Systems</td></tr>
<tr><td>Teaching Methodology</td><td colspan="3">Students are taught the course through lectures (3 hours per week) in classrooms or lectures theatres, by means of traditional tools or using computer demonstration.

Auditory exercises, where examples regarding matter represented at the lectures, are solved and further, questions related to particular open-ended topic issues are compiled by the students and answered, during the lecture or assigned as homework.

Topic notes are compiled by students, during the lecture which serve to cover the main issues under consideration and can also be downloaded</td></tr>
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	from the e-learning platform or the lecturer's webpage. Students are also advised to use the subject's textbook or reference books for further reading and practice in solving related exercises. Tutorial problems are also submitted as homework and these are solved during lectures or privately during lecturer's office hours. The plant parameter identification and the control actions of Linear and Tortional Control Systems are demonstrated in the Laboratory and design assignment work is assigned to the students, with the use of the Apparatus. Furthermore, design projects may be assigned to the students, where literature search is encouraged to identify a specific problem related to some issue, gather relevant scientific information about how others have addressed the problem, implement to implement the design and report the results in written or orally.
Bibliography	**Textbook** • R.C. Dorf and R.H. Bishop, Modern Control Systems, 13th Ed. Prentice Hall, 2016 **References** • K. Ogata, Modern Control Engineering, 5th Ed., Prentice Hall, 2015
Assessment	The Students are assessed via continuous assessment throughout the duration of the Semester, which forms the Coursework grade and the final written exam. The coursework and the final exam grades are weighted 40% and 60%, respectively, and compose the final grade of the course. Various approaches are used for the continuous assessment of the students, such as mid-term written exam, oral exam, quizzes, design assignments, design projects and laboratory experiments. The assessment weight, date and time of each type of continuous assessment is being set at the beginning of the semester via the course outline. An indicative weighted continuous assessment of the course is shown below: • Assignments 10% • Homework 10% • Mid-Term written exams 40% • Design Project 30% • Quizzes 10% Students are prepared for final exam, by revision on the matter taught, problem solving and concept testing and are also trained to be able to deal with time constrains and revision timetable. The criteria considered for the assessment of each type of the continuous assessment and the final exam of the course are: (i) the comprehension of the fundamental concepts and theory of each topic, (ii) the application of the theory in solving related problems and (iii) the ability to apply the above knowledge in more complex design problems. The above criteria are weighted 30%, 40% and 30%, respectively. The final assessment of the students is formative and summative and is assured to comply with the subject's expected learning outcomes and the quality of the course.
Language	English