AEEE543 - Digital Control Systems

Course Title	Digital Control Systems				
Course Code	AEEE543				
Course Type	Technical Elective				
Level	MSc (Level 2)				
Year / Semester	1 or 2				
Teacher's Name	Assoc. Prof. Marios Lestas				
ECTS	8	Lectures / week	3	Laboratories/week	0
Course Purpose	The aim of the course is to familiarize students with the basic concepts and principles of digital feedback control system design, analyzing different stages of the design procedure: sampling and data reconstruction, performance characterization and controller design using state-space methods, frequency response methods and root locus.				
Learning Outcomes	By the end of the course, students must be able to: 1. Define the z-transform and outline its main properties. 2. Identify the main components of Discrete-Time control systems, exemplifying the processes of Quantization and Data Acquisition. 3. Perform z-plane analysis in discrete-time control systems via Impulse Sampling and Data Hold, Convolution Integral Method, and reconstruction from sampled data. 4. Discretize continuous time state space representations of dynamical systems and apply state-space analysis and solve the discrete-time state space equations. 5. Evaluate the performance of Digital Controllers and Digital filters in discrete-time control systems in terms of their steady state and transient behaviour. 6. Examine the stability of Discrete Time Systems. 7. Design digital controllers using frequency response and root locus methods. 8. Evaluate the performance of discrete-time control systems by applying Controllability, Observability concepts. 9. Derive the Canonical forms of the state-space equations of discrete-time control systems. 10. Design state feedback controllers for pole placement. 11. Derive discrete time implementations of continuous time filters and controllers				
Prerequisites	None	Corequisites	None		

Course Content	**Introduction:** Main Components of Digital Control Systems, Quantization and Data Acquisition. **The Z-transform**: Definition, Translation, Complex Translation, Initial and Final Value Theorems, Real and Complex Convolution, Inverse z-transform **Z-plane Analysis:** Impulse Sampling and Data Hold, Ideal Sampler, Pulse Amplitute Modulator, Starred Transform, Sampling Theorem, Data Reconstruction, Hold Devices, Zero Order and First Order Hold Transafer Functions, Pulse Transfer Function, Z-Transfer Function, Submultiple Sampling, Modified z-transform, Sampling with Multiple Rates. **State-space Analysis**: Discretization of Continuous Time State Space Models, Discrete Time Transfer Function, Solution of the discrete-time state space equations, Controllability, Observability, Decomposition of Digital Systems. **Stability:** Poles, Eigenvalues, Jurys test, Raible's Table, Routh Hurwitz Criterion. **Performance Evaluation:** Transient and Steady State Response Analysis, damping, natural frequency, settling time, steady state error, postion, velocity constant. **Design of discrete time control systems**: Sensitivity, Disturbance Rejection, Frequency Response Methods, Root Locus, Digital PID Controller, Sampled Data Transformation of Analogue Filters, Pole placement via State Feedback.
Teaching Methodology	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 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. 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. Where appropriate, taught material as well as examples and design problems are drawn from the recent research activities of the lecturer or other faculty members.
Bibliography	**(a) <u>Textbooks:</u>** • C.L. Philips, H.T. Nagle, A. Chakraportty, **Digital Control System Analysis and Design**, Pearson, 4^{th} Edition, 2015. **(b) <u>References:</u>**

	• G.F. Franklin, J.P. Powell and M. L. Workman , ***Digital Control of Dynamic Systems***, Pearson Prentice Hall, 3rd Edition, 1997. • K. Ogata, **Discrete-Time Control Systems**, Prentice Hall, 2nd Edition, 1995.
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 and design projects. 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 20% • Quizzes 20% 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**