ECE 412- Digital Controls and Digital Filters **Spring 2020**

Class Hours: 11:00a.m.-12:15p.m. Tuesdays and Thursdays

Place: ENGR B2

Prerequisites: ECE411 or consent of instructor

Textbook: C. L. Phillips and H. T. Nagle, Jr., "Digital Control System Analysis and Design," Fourth Ed., Pearson, 2015

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Course Description:

The purpose of this course is to introduce the students to digital control systems analysis and design using both classical and modern approaches. The specific topics that will be covered include: z-transform and properties, discrete-time systems and representation, sampling and reconstruction, state-space representation, stability, controllability and observability of digital control systems, digital filters types and design, digital compensator design using classical and modern approaches, practical consideration and case studies.

Grading and Exams:

Homework	20%	
Computer Assignments	20%	
Mid-term Exam	25%	(Tentative date: Thursday March 26, 2020)
Final Exam	35%	

- There will be two computer assignments using MATLAB toolboxes.
- Exams are open book/notes.
- While NO collaboration is allowed on biweekly homework, a reasonable level of collaboration is acceptable on the computer assignments.

Course Outline and Schedule

Lecture	Chapter	Topic
1	**1**	Overview of digital control systems and their advantages and challenges.
2-5	**2**	z-transform and properties, discrete-time systems representation using difference equation, transfer function and state-space methods, time domain and z-domain solution of linear time-invariant (LTI) systems.
6-7	**2**	Mapping of difference equations to different state-space realizations, state diagrams, time domain and z-domain solution of LTI systems in state-space.
8-10	**3**	Sampling and reconstruction, ideal sampler, frequency-domain effects of sampling, sampling theorem and aliasing, sampled Laplace transform and properties, signal reconstruction and hold devices and properties.
11-14	**4**	Open-loop discrete-time systems, the pulse transfer function, open-loop systems with digital filters, modified z-transform and applications, systems with time delays, sampling of continuous-time state-space system.
15-16	**5**	Closed-loop discrete-time systems, signal flow graph for sampled data systems.
17-18 and	**Handout**	Digital filter design steps, review of analog filters, types and properties, recursive or IIR filter design using impulse invariant and bilinear z-transformation methods, warping effects and remedy, digital filter transformation, non-recursive or FIR filter design using frequency sampling method.
19-22	**6,7**	Time-domain analysis, mapping between S-plane and Z-plane, steady-state error analysis, stability analysis, Jury's stability test, root locus method, Lyapunov stability, Nyquist criterion and plot for digital control systems.
23-26	**8**	Digital controller design using classical methods, system specifications, digital PID controller, design of digital control systems with deadbeat response, one-step deadbeat, Dahlin's method for deadbeat design, design of controllers using root locus method, phase lead, lag and lag-lead controllers.
27-28	**9**	Digital controller design using modern methods, pole placement, controllability and observability, conditions for pole assignment, state feedback method, Ackermann's formula, deadbeat response using pole placement, observer design.