CAEDMI
Central Asia Engineering Dentistry Medicine Institute

Alpha Institute of Technology

Course Syllabus

Course Title: MeRo 5011: Linear Control Systems

Lead Instructor: David H. Lim, PhD, Office: AIT # 30x, Dean's office

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Office hours: 2:00-4:00 pm, Tuesday and Thursday

1. Course Description

This course covers the theory and practice of designing and analyzing feedback control systems. Topics include an introduction to linear systems, modeling dynamic systems in the frequency domain and time domain using Laplace transform or transfer function with state-space representation, respectively. The course also addresses system stability of feedback control systems and transient response. Students conduct a control design project using a design tool such as MATLAB or Octave to implement feedback control design in a dynamic system

2. Basic Information

Course Academic Level: Master-level

MSc program: Mechatronics and Robotics

Course Semester: 1st Semester

Number of ECTS credits: 5

Course Prerequisites:
1. Physics: Classical Mechanics, Electricity and Magnetism
2. Mathematics: Differential Equations and Linear Algebra
3. Modeling: System Dynamics 2/3

	4.Tools: Familiarity with MATLAB, Octave, or other computer simulation tools to perform dynamic control simulations of linear systems (i.e. a system of differential equations)
Type of Assessment:	Graded
Mode of study:	Full-time

Mapping from grades to percentage:

Letter Grade	Numeric Value (GPA)	100-point Scale
A	4.0	93-100
A-	3.7	90-92
B+	3.3	87-89
B	3.0	83-86
B-	2.7	80-82
C+	2.3	77-79
C	2.0	73-76
C-	1.7	70-72
D+	1.3	67-69
D	1.0	63-66
D-	0.7	60-62
F	0.0	<60

3. Course Content

Includes lesson topics and the corresponding chapters from the textbooks for each week.

№ of week	Topic
Wk. 1	Introduction to the class: What you need Control system's design: Case study Physical model to the ordinary differential equations (ODE)
Wk. 2-3	Modeling in the Frequency Domain Laplace Transform, solving ODEs Transfer Functions: Electrical Network, Mechanical Systems,

	Electromechanical System
Wk. 4	Modeling in the Time Domain: State-Space Representation Transfer Function to/from State-Space model
Wk. 5	System Behaviors: 1st and 2nd order systems System Responses with poles and zeros
Wk. 6	Feedback Systems and Signal-Flow graphs
Wk. 7	System Stability: Characteristic Equation
Wk. 8	Mid-term test Introduction to the class project
Wk. 9	Steady-State Errors Root Locus (concept and observation)
Wk. 10	Drawing Root Locus: Stability and Transient Response
Wk. 11-12	Design P, PI, PID cascade controllers via Root Locus I
Wk. 13	Physical Realization of active /passive controllers Tools: MATLAB/Octave, Micro-Cap (circuit design tool)
Wk. 14	Frequency Response Techniques: Time response and stability Using Bode Plot and Nyquist diagram
Wk. 15	Lab work on the project and presentation
Wk. 16	Final project: Demo to Instructor

4. Learning Outcomes

1) Learn the process of modeling linear time-invariant (LTI) dynamical systems in dual domains: in the time domain using ordinary differential equations and in the Laplace domain (s-domain).
2) Understand the behavior of LTI systems qualitatively and quantitatively, both in the transient and steady-state regimes, and appreciate how it impacts the performance of electro-mechanical systems, such as a DC motor.
3) Introduce feedback control and understand, using the s-domain primarily, how feedback impacts transient and steady-state performance.
4) Learn how to design proportional, proportional-integral, proportional-derivative, and proportional-integral-derivative feedback control systems meeting specific system performance requirements.
5) Introduce qualitatively the frequency response of LTI systems and how it relates to the transient and steady-state system performance.

5. Assignments and Grading

Assignment Type	% of Final Course Grade
Attendance	10
four to six select take-home assignment	40
Midterm Test	20
Final Project	30 (15 - project report; 15 - oral presentation)

6. Assessment Criteria

Assignments are to be returned within eight days in general (or the specified period in the assignment handout), from the day they are given. Some of the assignments require solution of differential equations and equations in S (Laplace operator) domain. You may use MATLAB (online) or Octave for solution of your assignment and final project.

Midterm Test a paper exam is given to students in class during the middle of the semester

The final project topic will be given to students by the instructor. The project has to be submitted in the form of a report and should be presented orally in the classroom. The final projects are to be submitted and oral presentations will be scheduled in the last week of classes, 3/3 mostly during the class hours. Consulting between teams and with others inside this class is highly encouraged.
Honor system must be strictly adhered to. Interaction among the students is encouraged to broaden the understanding of the subject. But the assignments and tests should not be discussed. All the assignments, midterm test and the final project have to come entirely from your own efforts and pledged so by you on the first page.

7. Textbooks and Internet Resources

Required Textbooks:

1) Nise, Norman S, Control Systems Engineering, John Wiley & Sons, 7th Edition

Recommended Textbooks:

1) Gene F. Franklin, J. David Powell, Abbas Emamin-Naeini, “Feedback Control of Dynamic Systems”, Pearson, 8th Edition
2) Karl Johan Astrom, Richard M. Murray, “Feedback Systems: An Introduction for Scientists and Engineers”, Princton University Press, Second Edition

8. Facilities

Required Course Materials (software or equipment): MATLAB {No simulink; only programmable MATLAB for this class}
Optional: Additional notes and articles from the instructor.

9. Additional Notes

I will be out of the country between September 13 - 20. Accordingly, I would like to conduct a makeup class, unless there are any objections to this. Thank you for your understanding and cooperation.