ME 177

Yet Another Control Systems Course

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TLN: ME 2 T 16:00–18:00 | *WLN*: ME 2 W 16:00–18:00.

COURSE OBJECTIVES

This course recalls, reinforces, and extends knowledge of control systems engineering, and focuses on modern control systems, i.e. modeling, analysis, and design in state space. It assumes nothing about students' capacity in a previous control systems course. This course aims to:

- Reinforce and extend students' knowledge of control systems engineering so they can use it to model, analyze, and design engineering products and systems.
- Introduce students to the beautiful world of modern control engineering.
- Provide students with the ability to model dynamical systems, and analyze and design control systems, especially those that are more tractable in the state space context.
- Let students apply their knowledge of programming and numerical methods on the modeling of dynamical systems, and analysis and design of control systems.
- Enhance students' analytical and problem-solving skills via a reasonable number of guided and unguided problem-solving exercises.

LEARNING OUTCOMES

After successful completion of the course, students should be able to:

- Define and explain fundamental concepts in control systems engineering, especially those in modern control.
- Identify, classify, and describe control systems encountered in everyday life and thug life.
- Mathematically model dynamical systems and apply appropriate simplifying assumptions.
- Analyze and design control systems, especially in the state space context.
- Systematically solve engineering problems involving control systems.
- Explain the importance of control systems, especially modern ones, in the entirety of engineering.

COURSE REFERENCES

- Friedland, B. (2005). *Control System Design: An Introduction to State-Space Methods*. Mineola, NY: Dover. (Original work published 1986) **CSD*
- Ogata, K. (2010). *Modern Control Engineering* (5th ed.). Upper Saddle River, NJ: Pearson. **MCE*
- Nise, N.S. (2011). *Control Systems Engineering* (6th ed.). Hoboken, NJ: Wiley.
- Lewis, J.W. (1994). *Modeling Engineering Systems: PC-Based Techniques and Design Tools*. Solana Beach, CA: HighText.

CALENDAR

Lecture	Topics	Activities
0	Course introduction	
Introduction to Modern Control Engineering		
1	Classical and modern feedback control	R1: *MCE* 1.1–1.4, *CSD* 1.1–1.4
Mathematical Modeling of Dynamical Systems		
2	Transfer functions and SISO control systems	A1; R2: *MCE* 2.1–2.3
3	State space representation	A2; R3: *CSD* 2.1–2.3, *MCE* 2.4–2.6
4	Mathematical modeling of mechanical and electrical systems	A3; R4: *MCE* 3.1–3.3
5	Mathematical modeling of thermal and fluid systems	A4; R5: *MCE* 4.1–4.5
6	Specific examples of state space modeling	A5; R6: *CSD* 2.4–2.7
Analysis of Dynamical System Models		
7	Solutions of linear dynamical systems	A6; R7: *CSD* 3.1–3.5
8	Variable transformations and canonical forms	A7; R8: *CSD* 3.6–3.7, *MCE* 9.1–9.3
9	Revisiting frequency-domain analysis: stability and graphical methods	A8; R9: *CSD* 4.1–4.6
	End of midterm exam coverage	
Controllability and Observability		
10	The concepts of controllability and observability	A9; R10: *CSD* 5.1–5.4
11	Clearing the mud of controllability and observability	A10; R11: *MCE* 9.6–9.7, *CSD* 5.4–5.5
Control Systems Design in State Space		
12	Pole placement in controllable systems	A11; R12: *CSD* 6.1–6.5, *MCE* 10.1–10.3
13	Using observers for design	A12; R13: *CSD* 7.1–7.5, *MCE* 10.5
14	The separation principle	A13; R14: *CSD* 8.1–8.7, *MCE* 10.6–10.7
	End of final exam coverage	
Modern Control Engineering and Beyond		
15	Local and international industries: what's the problem?	

REQUIREMENTS

- *Readings*. 14 instances at 0% each. Students should read assigned readings before corresponding lectures.
- *Assignments*. 14 instances at 2% each. Collaboration is highly encouraged and allowed but copying is not. All should be submitted in due time; failure to do so will result to a grade of 5.0.
- *Exams*. The midterm exam is 32% and the final exam is 40%. Scores are out of 100 and should not go below 30.