MECH 421: Mechatronic System Instrumentation

2020-2021 Term 2

Last updated: Jan 11, 2021

Objectives

Learn a systematic way of integrating together what you have learned in previous courses to design and control feedback mechatronic systems.

- Circuits: Linear circuits, Op-amp circuits, Power amplifier, Differential measurement.
- Controls: LTI systems, Loop shaping, Digital control, Noise filtering.
- Motors: Brushed DC motors, Brushless DC motors.

Contact Information

Instructor:	Dr. Minkyun Noh	(mnoh@mech.ubc.ca)
TA:	Hamed Helisaz	(hamed.helisaz@ubc.ca)
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Office Hours

Instructor:	After lectures and/or by appointment
TA:	by appointment

Lectures

Lectures are a main means of delivering MECH 421 contents and announcements. There will be 25 lectures including one in-class mid-term quiz. Live (synchronous) lectures will be delivered via CANVAS – Zoom. The lectures will be recorded for use by students enrolled in this course, but these recordings will not be used beyond the current section of the course. Please be aware that student participation, such as when asking questions in class, will be captures as part of these recordings. Lecture notes will be posted on CANVAS.

- Time: Monday 3-4pm and Friday 10-11am (PST)
- Location: CANVAS–Zoom
- Requirement: Computer and internet access (Optional: microphone and camera)

Tutorials

- Time: Wednesday 2-3 pm (PST)
- Location: CANVAS–Zoom
- Requirement: Computer and internet access (Optional: microphone and camera)

Labs

Labs are a major component of MECH 421. There will be 4 labs during the course.

- Lab 1: Voltage power amplifier
- Lab 2: Transconductance power amplifier
- Lab 3: Motor position servo loop design
- Lab 4: Brushless DC motor control

For each lab, students are asked to submit a prelab report and a lab report. Manuals for prelab and lab reports will be posted on CANVAS in advance. The lab sessions will be hosted by TAs

via CANVAS–Zoom. Students will participate the sessions in groups of 4-5 students. Group members are encouraged to collaborate during the lab sessions, but NOT for the prelab and lab reports; each group member should come up with their own prelab and lab reports based on their individual effort. Each student MUST submit a prelab report before the lab session. Late submission of a lab report will incur score deduction of 10% per day.

- Prelab report due: at the beginning of the lab session
- Lab report due: at the beginning of the next lab session (except the last one)

Homework

There will be 8 problem sets. Each problem set will be posted on CANVAS a week before the due date. Late submission will incur score deduction of 10% per day.

- Problem set due: at the beginning of the Friday lecture

Mid-term Quiz

- Mar 1st in class. Open-book and open-note, but it is highly recommended to prepare 1 sheet of summary note to save your time.

Design Problem

- The final exam will be substituted with a design problem.

References

There is no required textbooks.

Course Grading

Prelab (20%) + Lab (20%) + Homework (20%) + Mid-term quiz (20%) + Design problem (20%)

Course Schedule (Tentative)

Week	Date	Lecture	HW Out	Prelab Out	Lab
1	Jan 11	Feedback system			
	Jan 15	LTI systems review	1		
2	Jan 18	Op-amp static model			
	Jan 22	Op-amp dynamic model	2		
3	Jan 25	Loop shaping, 2nd order systems and others			
	Jan 29	Crossover frequency and phase margin		1	
4	Feb 1	Brushed DC motor			
	Feb 5	Voltage-controlled brushed DC motor	3		
5	Feb 8	Current-controlled brushed DC motor			1
	Feb 12	Transconductance amplifier		2	
6	Feb 15	**Midterm Break**			
	Feb 19				
7	Feb 22	Differential measurement			2
	Feb 26	Op-amp non-idealities	4		
8	Mar 1	**Mid-term quiz**			
	Mar 5	Feedback and stability – Nyquist		3	
9	Mar 8	Lead controller design			
	Mar 12	PI controller design	5		
10	Mar 15	Digital control, ADC: sampling, aliasing, quantization			3
	Mar 19	DAC: reconstruction, delay, etc.	6		
11	Mar 22	Digital control design via approximate mapping			
	Mar 26	Digital control design based on ZOH equivalent		4	
12	Mar 29	Brushless DC motor			
	Apr 2	Brushless DC motor commutation	7		
13	Apr 5	Introductory power electronics			4
	Apr 9	Electromagnetic interference reduction techniques	8		
14	Apr 12	Summary of the course			