MECH 550E/575B: Principles of Mechatronics - Instrumentation
Fall 2017

Instructor:	**Dr. Christoph Sielmann (**sielmann@mail.ubc.ca, Skype: christoph_1448)
Lectures:	Monday and Wednesday from 7:00 – 8:30PM in CEME 1202
Website:	Course content available through **UBC Connect** (http://connect.ubc.ca)
Contact:	Office hours available on request. I can be available most evenings/weekends, and will generally be available by Skype on Tuesday and Thursday from 8:00 – 10:00PM. Please include "MECH550E" in the subject line of any emails.
Lab	MECH 575B is required for this course. Labs are from Wed 9:00AM – 12:00PM in Kaiser 1210.

Equipment/Literature:

- All lab equipment will be provided by MECH, but students are required to bring laptops to the labs. Required software will be posted on the course website.
- There are no required textbooks for the course, but useful literature includes:
  - S. Brown and Z. Vranesic, *Fundamentals of Digital Logic with VHDL Design with CD-ROM*, 3 edition. Boston, Mass: McGraw-Hill Education, 2008.
  - A. S. Morris and R. Langari, *Measurement and Instrumentation: Theory and Application*, 1 edition. Waltham, MA: Butterworth-Heinemann, 2011.
  - B. P. Lathi, *Signal Processing and Linear Systems*. New York: Oxford University Press, 2001.
  - A. Sedra and K. Smith, *Microelectronic Circuits*, 6 edition. New York: Oxford University Press, 2009.

TAs

Varun Jacob-John, email varun.jacob-john@ubc.ca
Soheil Kianzad, email skianzad@cs.ubc.ca

Learning Objectives

- **UNIT 1: Analog circuits and devices**
  Learn practical analog circuit analysis, analog filter design, and amplifiers
- **UNIT 2: Logic and FPGAs**
  Simplify digital logic expressions, build logic blocks, program FPGAs using VHDL, and design basic digital filters for realizable designs
- **UNIT 3: ADCs and MCUs**
  Understand the principle of operation behind ADCs and MCUs, and how they are applied in real sensing applications.

Tentative Outline/Schedule

Date	Activity	Notes
Sept. 6	Introduction	Course introduction and Introduction to Information Theory
Sept. 11	Magnetics	Inductors through transformers with a focus on applications
Sept. 13	Circuits I	Circuit components and practical circuit design
Sept. 18	Circuits II	Mesh and nodal analysis of circuits using *s*-transforms, RLC networks
Sept. 20	Op. amps I	Simplified model, buffers, amplifiers, instrumentation amplifiers
Sept. 25	Analog filters I	Active, passive, and switched capacitor filters, bode plots, characterization
Sept. 27	LAB 1	RLC filter and gain block
Sept. 27	Op. amps II	Realistic op. amps, special cases/variations, real designs
Oct. 2	Analog filters II	Low/Band/High pass filter design, limitations and examples
Oct. 4	LAB 1 Pt. 2	RLC filter and gain block
Oct. 4	Discretionary	Review, Examples and Questions
Oct. 9	HOLIDAY	Thanksgiving
Oct. 11	LAB 2	Design and Characterization of an active analog filter
Oct. 11	Introductory logic	Truth tables, boolean logic, Karnaugh maps
Oct. 16	FPGAs I	Introduction, technology: anti-fuse, NVRAM (internal/external)
Oct. 18	VHDL	Introduction to VHDL
Oct. 23	FPGAs II	Complex and sequential circuits (latches, counters, adder, multipliers)
Oct. 25	LAB 3	Introduction to FPGA programming
Oct. 25	Digital Signals I	Introduction to DSP, FIR and IIR filters
Oct. 28	Digital Signals II	Design, implementation and performance of digital filters
Nov. 1	ADCs I	Analog to Digital conversion fundamentals and design
Nov. 6	ADCs II	ADC implementation and communication
Nov. 8	LAB 4	Exploring the ADC
Nov. 8	Digital Devices	PWM, H-bridges, D-class amplifiers, encoders, and other applications
Nov. 13	HOLIDAY	Remembrance Day
Nov. 15	MCUs I	Microprocessor design, memory, microcontrollers, and SoC devices
Nov. 20	MCUs II	Digital communication protocols, buses, DMA, and interrupts
Nov. 22	LAB 5 Pt. 1	Data acquisition system design
Nov. 22	MCUs III	RISC instruction set, compilers, and code efficiency
Nov. 27	Applications	Group design activity
Nov. 29	LAB 5 Pt. 2	Data acquisition system design
Nov. 29	Discretionary	Review, Examples and Questions

Marking Scheme

- 100% for assignments

Five assignments will be provided throughout the course, with 20% of the final course mark coming from each assignment. Please work independently and assume each assignment will require 15-25 hours of time.

Labs

This course is predominantly aimed at developing practical skills involving filter design, data acquisition, MCU programming, and signal analysis. The 5 labs are intended to offer students the opportunity to practice the practical concepts discussed in this course. Labs fall under a separate course number, and the lab reports form 100% of the grade of that course (20% per lab). Labs are conducted individually during the dedicated lab time assigned for each lab. Two TAs will be available during each lab to help facilitate and answer any questions. Lab reports are due **one week** after the completion of the lab. Attendance at each lab is **mandatory,** barring exceptional circumstances such as documented medical emergencies. It is also expected that students review the lab requirements in advance of the lab and complete all tasks within the assigned time (3 hours).

Note that all lab equipment is provided, but students may optionally purchase a DE1-SoC for their own practice and use. They can be purchased through ECE stores for a discounted price. The Instrumentation lab is not equipped with computers at each workstation, so please arrange to bring a laptop with the necessary lab software pre-installed. The course website will describe which software packages are necessary. If you do not have a laptop that you are willing to use during the lab then please notify the instructor as soon as possible.

Deadlines

Deadlines for assignments and lab reports are non-negotiable. Lab reports are due by 11:59PM on the indicated date (typically one week after assignment) and must be emailed directly to the instructor in either Word or PDF format. Assignments are typically due 2 weeks after assignment. Late assignments and lab reports will be docked 25% per day.

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

Calendar sections:
https://courses.students.ubc.ca/cs/main?dept=MECH&course=550E&section=101
https://courses.students.ubc.ca/cs/main?dept=MECH&course=575B&section=101