THE UNIVERSITY OF BRITISH COLUMBIA

Department of Mechanical Engineering
University of British Columbia
2054 - 6250 Applied Science Lane
Vancouver, BC Canada V6T 1Z4

Phone 604 822 2781
Fax 604 822 2403
www.mech.ubc.ca

MECH 466: Automatic Control (Term 2, 2019/20)

University of British Columbia

Department of Mechanical Engineering

Course Instructor: Dr. Ryozo Nagamune

Contact Information: Email: nagamune@mech.ubc.ca, Phone: 604-827-4344, Office: Kaiser 3104 (Drop-in or by appointment)

Teaching Assistants

Ms. Nafise Rad (nafise.faridi@gmail.com)
Mr. Mohammadreza Rostam (pooya.rostam@gmail.com)
Mr. Jacob Morrison (jadm@mail.ubc.ca)
SH: Sara Hosseinirad (sara.hosseini.rad@gmail.com)
HH: Hamed Helisaz (hamedhelisaz@gmail.com)
BK: Behnam Karimi (benhamk71@gmail.com)

Class Meeting Time and Location

MWF 8-9:20pm, Location: DMP (Hugh Dempster Pavilion) 310

Course Structure

Lectures with lecture slides, exercise problems with solutions, homework assignments, and labs

Learning Objectives

This course is an introductory course on automatic control. The main goal of the course is to provide the students with basic tools in modeling, analysis and design for linear feedback control systems. Students will learn how to model mechanical, electrical, and electromechanical systems as differential equations and transfer functions. The analysis in this course includes stability of open-loop and closed-loop systems, time responses and frequency responses of low order systems. The design methods are divided into root-locus techniques and frequency response techniques using Bode plots for designing PID and lead/lag controllers. Students will also learn how to apply control theory to real engineering problems with Matlab/Simulink and through laboratory exercises.

This course will give the basic knowledge for more advanced control courses, such as state-space control techniques, nonlinear control, robust control, optimal control, adaptive control, digital control, sampled-data control, hybrid control, and system identification.

Course Schedule and Topics

Week	Topics
1-2	Introduction, Laplace transform
3	Modeling
4	Stability, Routh-Hurwitz stability criterion
5	Time response
6-7	Root locus
8	**Midterm (Feb. 27, Thursday, 8:10-9:10am)**
9	Frequency response
10-11	Nyquist stability criterion, stability margin
12	Frequency shaping
13	Course summary

Learning Activities

Laboratory exercises in Kaiser 1160

Students are required to conduct four laboratory exercises.

Water tank level control

Lab 1: January 20 - 31

Lab 2: February 3 -14

DC motor control, including MATLAB exercises

Lab 3: March 2 - 13

Lab 4: March 16 – 27

The labs are an integral part of the course and all labs must be completed to pass the course. Laboratories will be performed in teams. TAs will be available in the labs during the scheduled lab times. (See the lab schedule document.)

A short lab report must be handed in by the due date (given in the lab schedule document). A lengthy report is not required. The report should include answers to any questions posed in lab manuals. Each lab will be marked out of 10.

If a lab is not demonstrated on time you will receive a maximum mark of 2.5/10 (assuming that you conduct four labs). Remember that you must complete all labs, even if late, to pass the course. If you miss a lab, contact TA for rescheduling. Since this is a group effort, only lab report per group needs to be submitted, clearly writing the names of all students on the report. Do not write names of students who were absent or did not participate.

Course Requirements/Prerequisites

Either (a) all of MECH 220, MECH 221, MECH 463 or (b) all of MATH 255, MECH 463 and one of ELEC 201, ELEC 202, EECE 251, EECE 253.

Learning Materials: Required Textbooks: None. Optional textbooks are

- Feedback Control Systems (5th Edition) C. Phillips and J. Parr, Prentice Hall, 2011.
- Control Systems Engineering (7th Edition) N. S. Nise, Wiley & Sons, 2014.
- Feedback Control of Dynamic Systems (7th Edition) G. Franklin, J. Powell, and A. Emami-Naeini, Prentice-Hall, 2014.
- Modern Control Engineering (5th Edition) K. Ogata, Prentice Hall, 2009.
- Modern Control Systems (12th Edition) R. Dorf and R. Bishop, Prentice Hall, 2010.
- Mechatronics: An Integrated Approach C. W. de Silva, CRC Press, 2004.
- Feedback Systems: An Introduction for Scientists and Engineers K. J. Astrom and R. M. Murray, Princeton University Press, 2008. http://www.cds.caltech.edu/~murray/amwiki/Main_Page

All materials (lecture slides, lab manuals, exercise problems, homework etc.) are posted on Canvas.

Assessment, Evaluation, and Grading

Grading scheme: Lab (10%), Homework (10%) Mid-term (20%), Final (60%)

Homework assignment: Assignments will be given out almost weekly. Your solutions should be handed in by the due date/time. Late assignments will be given a mark of zero. Assignments are to be done **individually**. **Copying another student's assignment is NOT allowed.** Possible penalties for plagiarism include a mark of zero for all assignments.

Exam Policies: Closed-book. Calculators are not allowed. One page letter-size hand-written cheat-sheet (both sides) is allowed. Alternative exams can be arranged ONLY for medical reasons and with doctor's notes. For other reasons, discuss your case with the instructor before the exam dates.

In undergraduate MECH courses where at least 50% of the final grade is assigned to examinations, students may only pass the course if they achieve a weighted average examination grade of at least 50%. The "examination grade" includes scores from the final examination, midterms, and other tests done individually in a classroom setting.

Academic Misconduct

Academic honesty is a fundamental requirement of your studies. It is your obligation to inform yourself of the applicable standards. More information is available at *http://calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,0*.

Policies and Resources to Support Student Success

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available at https://senate.ubc.ca/policies-resources-support-student-success. Mechanical

Engineering also has a Student Services Office (students@mech.ubc.ca), located in CEME 2205, where there are staff who can provide support and refer students to the appropriate resources.

Inclusive Environment

The Department of Mechanical Engineering is committed to providing an inclusive learning experience, and affirms the UBC Statement on Respectful Environment (https://www.hr.ubc.ca/respectful-environment/files/UBC-Statement-on-Respectful-Environment-2014.pdf). You are encouraged to contact their instructor should situations arise that are not consistent with this expectation. You are also invited to advise the instructor if you wish to be addressed by or referred to with particular pronouns.

Laboratory Safety

UBC Mechanical Engineering considers safety first, and continuously, in its labs, research, and other activities. Students are expected to engage in safety discussions; to ask questions to ensure they understand safety information; to comply with policies and rules; to maintain a safe workspace; and to report all accidents, incidents, and near misses immediately to their supervisor and to https://cairs.ubc.ca. Students should work with their supervisors to ensure they understand (1) the risks associated with their work and (2) how those risks are controlled.