THE UNIVERSITY OF BRITISH COLUMBIA

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MECH 366: Modeling of Mechatronic Systems (Term 1, 2019/20)

University of British Columbia

Department of Mechanical Engineering

Course Instructor: Dr. Ryozo Nagamune

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Class Meeting Time and Location

Mondays & Fridays 3-3:50pm, Location: CEME 1215

Course Structure

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

Learning Objectives

1. Mathematical modeling of physical systems. You will be expected to analyze a complex system and select the appropriate models for individual components. You will be expected to analyze the system in time, frequency and Laplace domains. You will be expected to know which domain is most appropriate for a given system, and how to go between different domains.

2. Building common differential equations for electrical and mechanical systems. You will be expected to apply time-domain, frequency-domain and Laplace-domain equations to model a physical system. You will be expected to apply the same mathematical equations to mechanical, electrical, thermal, and fluid systems. You will be expected to investigate, compare and combine these different systems into a single mathematical framework.

3. Engineering analysis of performance of integrated mechatronics systems in time and frequency domain. You will be expected to select and apply standard performance specifications to measure the performance of a system. You will be expected to compare performance specifications and understand their limitations. You will be expected to present these performance specifications numerically and graphically. You will be expected to appreciate the benefits and limitations of standardized performance metrics.

Course Schedule and Topics (Tentative)

Week	Topics
1-3	Introduction,Terminologies, Modeling procedure, Analogies, State-space representation, Linearization
4-5	Linear graph, Modeling of mechanical and electrical systems
6	Modeling of DC motor, **Midterm (Oct. 11, Friday, 3-3:50pm)**
7-8	Modeling of fluid and thermal systems
9-10	Laplace transform, Transfer function
11-12	Step response, Frequency response
13	Project presentation, Course summary

Learning Activities

Laboratory exercises in Kaiser 1160: Lab1: Sep 20, Lab2: Sep 27, Lab3: Oct 18 & 25, Lab4: Nov 1 & 8

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. Two lab sessions are scheduled for each lab (except Labs 1, 2 which only requires one session) and the TA 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.

Project: Nov 15 & 22

Each lab group is required to make a dynamic model of a real physical mechatronic system. The project group ((G1: A1-A3, G2: A4-A6, G3: B1-B3, G4: B4-B6) can share a physical system and the data for modeling and model validation, but the model needs to be developed by each lab group. You must complete the project to pass the course.

Sep 13 (Friday): During your scheduled lab time (G1: 10am, G2: 11am, G3: 1pm, G4: 2pm), the instructor and TAs will discuss your project in Kaiser 1160.

Project presentation will be held on Nov 29 (Friday).

Project report from each lab group (A1, A2, etc., NOT project group) needs to be submitted after Nov 29. The report due date is to be determined.

Course Requirements/Prerequisites: Either (a) all of MECH 220, MECH 223, MECH 224, MECH 225 or (b) all of ENPH 253, MECH 260 and one of ELEC 201, EECE 251

Learning Materials

Required Textbooks: None. Optional Textbook: Chapters 1-4 of the book “Modeling and Control of Engineering Systems”, CRC Press, 2009, by C. W. de Silva

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

Assessment, Evaluation, and Grading

Grading scheme: Lab (10%), Project (20%), Homework (10%) Mid-term (20%), Final (40%)

Homework assignment: Assignments will be given out periodically. 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.