COURSE OUTLINE
WINTER 2024

	Date	Initials
Prepared by Instructor	Arne Dankers	
Approved by Head	07-Jan	amk

1. Calendar Information

ENEL 441
Control Systems 1

Component modelling and block diagram representation of feedback control systems. Mathematical modelling of dynamic systems; state-space representation and frequency domain representation of dynamic systems. Transient response analysis and steady-state error analysis. Root-locus analysis and design. Frequency response analysis with Bode and Nyquist stability criterion. Compensation design techniques. Introduction to multi sensor state feedback compensator design.

Course Hours: 3 units; H(3-1T-3/2)
Academic Credit: 3
Calendar Reference: https://www.ucalgary.ca/pubs/calendar/current/electrical-engineering.html#7620

2. Learning Outcomes

At the end of this course, you will be able to:

1 Construct mathematical models of simple electrical, mechanical and mechatronic systems (Unit 1).
2 Represent and analyze a system using transfer functions, state-space equations and frequency domain representations (Unit 1).
3 Determine properties of the transient response of a given system (rise time, over shoot, settling time) using s-plane plots (Unit 1).
4 Analyze sensitivity functions of a closed loop system and use these plots to guide control design (loop shaping) (Unit 2).
5 Determine the stability and robustness of a feedback system using Nyquist and Bode plots (Unit 2).
6 Design P controllers using Root Locus Plots. Design PD, PI, and PID controllers to meet design requirements (Unit 3).
7 Design lead/lag compensators to meet design requirements (Unit 4).
8 Design controllers using state feedback (pole placement) to meet design requirements (Unit 5).
9 Analyze multi-input, multi-output closed loop systems (Unit 5).

3. Timetable

Section	Day(s) of the Week	Time	Location
LEC 01	MWF	10:00-10:50	ENE 243
LAB B01	R	14:00-16:50	ENG 203
LAB B02	R	14:00-16:50	ENG 203
TUT T01	T	08:30-09:20	ENE 243

4. Course Instructors

Course Coordinator

Section	First Name	Family Name	Phone	Office	Email
	Arne	Dankers	403-220-	ICT413	arne.dankers2@ucalgary.ca

Other Instructors

Section	First Name	Family Name	Phone	Office	Email

Teaching Assistants

Section	First Name	Family Name	Phone	Office	Email
	Shirin	Maneshkarimi			shirin.maneshkarimi@ucalgary.ca
	Mobina	Abdoli Nemati			mobina.abdolinemati@ucalgary.ca
	Mahsan	Ghasemi			afsaneh.ghasemi@ucalgary.ca
	Mahmood	Khalghollah			mahmood.khalghollah@ucalgary.ca
	Moshfiq-Us-Saleheen	Chowdhury			moshfiqussaleheen.ch@ucalgary.ca

5. Assessments

Note: If students miss a required component of the course with a valid reason, they must contact the instructor in writing within 24 hours to discuss the reasoning and options to submit and/or make-up for that component. The student must provide documentation supporting the reason for missing the course component.

Final Exam: There will be a 3 hour final exam scheduled by the registrar.

Quizzes: There will be 4 quizzes that will take place during scheduled tutorial sessions. Each quiz will be 50min duration and will cover the material of one unit. The best 3 out of 4 quizzes will be used to calculate the final grade.
Quiz 1 - Unit 1 (System Modelling and Representations) - Tues. Feb 6
Quiz 2 - Unit 2 (Introduction to Control) - Tues. Feb 27
Quiz 3 - Unit 3 (PID Control) - Tues. March 19
Quiz 4 - Unit 4 (Lead/Lag Compensators) - Tues. April 2

Assignments - There will be 4 take home assignments. Each assignment will cover the material of one unit. Assignments will be due by 5pm and must be submitted electronically via D2L.
Assignment 1 - Unit 1 (System Modelling and Representations) - Tues. Jan 30
Assignment 2 - Unit 2 (Introduction to Control) - Tues. Feb. 13
Assignment 3 - Unit 3 (PID Control) - Tues. March 12
Assignment 4 - Unit 4 (Lead/Lag Compensators) - Tues. March 26

Labs - There will be four labs that will be held during lab sessions. Each lab must be completed during the scheduled time. The first lab will start on Feb. 8 (B01) and Feb 15 (B02).

For reappraisals of term work or final assessments, please refer to the SSE Reappraisal of Graded Term Work and Academic Assessments Policy (https://schulich.ucalgary.ca/sites/default/files/teams/1/SSE%20Reappraisal%20Policy.pdf) and forms are available on the Engineering Student Center D2L site.

6. Use of Calculators in Examinations

You may use any calculator you wish for studying and completing lab reports. However, you must use only one of the following sanctioned Schulich School of Engineering calculators during exams: Casio FX-260S, Casio FX-300MS, Casio FX-95ES Plus, Casio FX-300ESPLUS2 (2nd Edition), TI-30XIIS, TI-30Xa, Sharp EL-531XTB-WH, and HP10S Plus.

7. Final Grade Determination

The final grade in this course will be based on the following components:

Component	Learning Outcome(s) Evaluated	Weight
Quizzes	1-8	40%
Assignments	1-8	10%
Labs	1-8	10%
Final Exam	1-8	40%

Total: 100%

It is necessary to obtain a grade of 50% on the final in order to pass the course.

Conversion from a score out of 100 to a letter grade will be done using the conversion chart shown below. This grading scale can only be changed during the term if the grades will not be lowered.

Letter Grade	Total Mark (T)		
A+		T ≥	95.0%
A	90.0%	≤ T <	95.0%
A-	85.0%	≤ T <	90.0%
B+	80.0%	≤ T <	85.0%
B	75.0%	≤ T <	80.0%
B-	70.0%	≤ T <	75.0%
C+	65.0%	≤ T <	70.0%
C	60.0%	≤ T <	65.0%
C-	55.0%	≤ T <	60.0%
D+	50.0%	≤ T <	55.0%
D	45.0%	≤ T <	50.0%
F		T <	45.0%

8. Textbook

The following textbook(s) is required for this course:

Title	
Author(s)	
Edition, Year	
Publisher	

The following textbook(s) is recommended for this course:

Title	Modern Control Engineering
Author(s)	Katsuhiko Ogata
Edition, Year	5'th Edition, 2010
Publisher	Prentice Hall

9. University of Calgary Policies and Supports

SSE ADVISING AND POLICIES

All Schulich School of Engineering students have access to a D2L site titled “Engineering Student Centre”. Students have a responsibility to familiarize themselves with the policies available on this site.

ACADEMIC MISCONDUCT

Academic Misconduct refers to student behavior which compromises proper assessment of a student’s academic activities and includes: cheating; fabrication; falsification; plagiarism; unauthorized assistance; failure to comply with an instructor’s expectations regarding conduct required of students completing academic assessments in their courses; and failure to comply with exam regulations applied by the Registrar.

For more information on the University of Calgary Student Academic Misconduct Policy and Procedure and the SSE Academic Misconduct Operating Standard, please visit: https://schulich.ucalgary.ca/current-students/undergraduate/student-resources/policies-and-procedures

Additional information is available on the Academic Integrity Website at https://ucalgary.ca/student-services/student-success/learning/academic-integrity

ACADEMIC ACCOMODATION

It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The Student Accommodations policy is available at https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Accommodation-Policy.pdf

Students needing an accommodation based on disability or medical concerns should contact Student Accessibility Services (SAS) in accordance with the Procedure for Accommodations for Students with Disabilities (https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Accommodation-for-Students-with-Disabilities-Procedure.pdf). SAS will process the request and issue letters of accommodation to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/.

Students needing an accommodation in relation to their coursework or to fulfil requirements for a degree based on a Protected Ground other than Disability, should communicate this need by submitting a SSE Request for Academic Accommodation Form (ESC D2L - Forms) to the Associate Head (Undergraduate Studies) within 10 business days prior to the class, test, exam, or assignment at issue.

INSTRUCTOR INTELLECTUAL PROPERTY

Course materials created by instructors (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the instructor. These materials may NOT be reproduced, redistributed or copied without the explicit consent of the instructor. The posting of course materials to third party websites such as note-sharing sites without permission is prohibited. Sharing of extracts of these course materials with other students enrolled in the course at the same time may be allowed under fair dealing.

FREEDOM OF INFORMATION AND PROTECTION OF PRIVACY

Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary.

COPYRIGHT LEGISLATION

All students are required to read the University of Calgary policy on Acceptable Use of Material Protected by Copyright (https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Acceptable-Use-of-Material-Protected-by-Copyright-Policy.pdf) and requirements of the copyright act (https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html) to ensure they are aware of the consequences of unauthorised sharing of course materials (including instructor notes, electronic versions of textbooks etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Student-Non-Academic-Misconduct-Policy.pdf.

MEDIA RECORDING (if applicable)

Please refer to the following statement on media recording of students: https://elearn.ucalgary.ca/wp-content/uploads/2020/05/Media-Recording-in-Learning-Environments-OSP_FINAL.pdf

**Media recording for lesson capture*

The instructor may use media recordings to capture the delivery of a lecture. These recordings are intended to be used for lecture capture only and will not be used for any other purpose. Although the recording device will be fixed on the Instructor, in the event that incidental student participation is recorded, the instructor will ensure that any identifiable content (video or audio) is masked, or will seek consent to include the identifiable student content to making the content available on University approved platforms.

**Media recording for self-assessment of teaching practices*

The instructor may use media recordings as a tool for self-assessment of their teaching practices. Although the recording device will be fixed on the instructor, it is possible that student participation in the course may be inadvertently captured. These recordings will be used for instructor self-assessment only and will not be used for any other purpose.

**Media recording for the assessment of student learning*

The instructor may use media recordings as part of the assessment of students. This may include but is not limited to classroom discussions, presentations, clinical practice, or skills testing that occur during the course. These recordings will be used for student assessment purposes only and will not be shared or used for any other purpose.

SEXUAL VIOLENCE POLICY

The University recognizes that all members of the University Community should be able to learn, work, teach and live in an environment where they are free from harassment, discrimination, and violence. The University of Calgary's sexual violence policy guides us in how we respond to incidents of sexual violence, including supports available to those who have experienced or witnessed sexual violence, or those who are alleged to have committed sexual violence. It provides clear response procedures and timelines, defines complex concepts, and addresses incidents that occur off-campus in certain circumstances. Please see the policy available at https://www.ucalgary.ca/legal-services/sites/default/files/teams/1/Policies-Sexual-and-Gender-Based-Violence-Policy.pdf

OTHER IMPORTANT INFORMATION

Please visit the Registrar's website at: https://www.ucalgary.ca/registrar/registration/course-outlines for additional important information on the following:

- Wellness and Mental Health Resources
- Student Success
- Student Ombuds Office
- Student Union (SU) Information
- Graduate Students' Association (GSA) Information
- Emergency Evacuation/Assembly Points
- Safewalk

10. Additional Course Information

Course Format and Scheduling

Guidelines for Completing and Submitting Coursework