# MEEN5600

# Feedback Control of Dynamical Systems

## Instructor Information

- **Name:** Jiho Lee
- **Pronouns:** he, him, his
- **Office Location:** F115-K
- **Class Meetings:** (NTDP F185) Mon/Wed 08:30 AM - 09:50 AM
- **Office Hours:** Mon/Wed 10:00 AM – 12:00 PM
- **Email:** jiho.lee@unt.edu
- **Communication Expectations:**
  The instructor will communicate with students primarily through email and Canvas. Please use my email to contact me with any questions, and I will get back to you within **two business days**. Feedback on assignments will typically be provided within **two weeks** of the due date.
  All course materials will be available on Canvas:
  - **Lecture slides (PDFs)** will be posted directly on Canvas.
  - **Homework assignments** will be managed (announcements and submissions) through Canvas.

  Canvas announcements and email through Canvas will be the primary channels for communication with students. All graded homework and exams will also be posted on Canvas.

## Welcome to UNT!

As members of the UNT community, we have all made a commitment to being part of an institution that respects and values the identities of the students and employees with whom we interact. UNT does not tolerate identity-based discrimination, harassment, and retaliation. UNT's full Non-Discrimination Policy can be found in the UNT Policies section of the syllabus.

## Course Description

This course introduces the fundamental principles of modeling, analysis, and control of dynamic systems. Topics include mathematical modeling of dynamic systems; Laplace transform solutions of differential equations; transfer functions and system responses in the time and frequency domains; control system design; state-space-based analysis; and computer simulation for control system design (MATLAB).

Prerequisite recommended: MEEN3230

## Course Schedule

The schedule and topics covered are subject to change during the semester.

| Week | Date | Content |
|---|---|---|
| 1 | Jan-12 | Introduction |
| | Jan-14 | Poles and Zeros |
| 2 | Jan-19 | No class (Martin Luther King Jr. Holiday) |
| | Jan-21 | Control System Configurations and Preliminary Analysis |
| 3 | Jan-26 | Stability (Routh-Hurwitz) |
| | Jan-28 | Steady State Error |
| 4 | Feb-02 | Direct Pole Placement |
| | Feb-04 | |
| 5 | Feb-09 | Root Locus |
| | Feb-11 | |
| 6 | Feb-16 | Root Locus-Based Controller Design (PID) |
| | Feb-18 | |
| 7 | Feb-23 | *Review for Exam 1* |
| | **Feb-25** | **Midterm Exam 1** |
| 8 | Mar-02 | Stability Margins |
| | Mar-04 | Nyquist Plots and Stability |
| - | Mar-09 | Spring Break |
| | Mar-11 | |
| 9 | Mar-16 | Closed Loop Performance from Open Loop Frequency Response |
| | Mar-18 | Frequency Domain Controller Design 1 (Bode & Margins) |
| 10 | Mar-23 | Frequency Domain Controller Design 2 (Loop Shaping) |
| | Mar-25 | Frequency Domain Controller Design 3 (Lead/Lag) |
| 11 | Mar-30 | Frequency Domain Controller Design 4 (Lead/Lag) |
| | Apr-01 | *Review for Exam 2* |
| 12 | **Apr-06** | **Midterm Exam 2** |
| | Apr-08 | No class |
| 13 | Apr-13 | Final Project Introduction |
| | Apr-15 | State-Space View of Feedback Control |
| 14 | Apr-20 | Robustness, Sensitivity, and Limitations |
| | Apr-22 | Time Delay and Digital Controller |
| 15 | Apr-27 | Special Topic (e.g., Feedback Control in Modern Applications) |
| | Apr-29 | Course Review |
| 16 | **May-04** | **Final Presentations** |

## Course Objectives

By the end of this course, students will be able to:

- Explain the fundamental principles of modeling, analysis, and feedback control of dynamic systems using differential equations, Laplace transforms, and transfer functions.
- Analyze the stability and performance of linear time-invariant (LTI) systems using time-domain and frequency-domain techniques, including Routh-Hurwitz criterion, root locus, Bode plots, and Nyquist plots.
- Design feedback controllers using classical control methods, including root locus-based design, PID control, and frequency-domain compensator design.
- Understand control system behavior using a state-space perspective and assess robustness, sensitivity, and practical limitations of feedback control systems.
- Use computational tools (MATLAB) to model, simulate, and analyze dynamic systems and feedback controllers.
- This course contributes to the following **ABET Student Outcomes** for the Mechanical and Energy Engineering program:
    - An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
    - An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
    - An ability to communicate effectively with a range of audiences.
    - An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
    - An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Final Project

Students will complete a final team project in teams of **2–3 students**. Each team will select a control-related topic and design a feedback controller using the modeling, analysis, and design techniques covered in the course. The project will involve system modeling, controller design, and simulation-based performance evaluation. Each team will present their project at the end of the semester. **Project topics must be discussed with and approved by the instructor. A separate individual final report for graduate students will be announced after Exam 2.**

## Assignments (Homework)

**Five problem-solving assignments** will be given throughout the semester. All assignments will be announced and submitted through Canvas Assignments, and students are expected to strictly follow the posted due dates. Each assignment is worth 2 points. Assignments **must be solved by hand**, either on paper or using a tablet, and submitted as a scanned or photographed copy via Canvas. **Full credit (2 points) will be awarded** for handwritten submissions turned in on time, regardless of correctness. Late submissions will incur a penalty of 0.2 points per day. **Solutions will be posted one week after the due date**, and any submission made after the solution is released will receive no credit (0 points).

## Grading Elements and Weights

| Assignment | *Percentage of Final Grade* |
|---|---|
| **Homework (5)** | *10%* |
| **Exam 1** | *25%* |
| **Exam 2** | *25%* |
| **Final Project (Team)** | *20%* |
| **Final Report (Individual)** | *10%* |
| **Attendance** | *10%* |
| **Total Points Possible** | ***100%*** |

- A: 80-100% (Outstanding, excellent work. The student performs well above the minimum criteria.)
- B: 70-79% (Good, impressive work. The student performs above the minimum criteria.)
- C: 60-69% (Solid, college-level work. The student meets the criteria of the assignments.)
- D: 50-59% (Below average work. The student fails to meet the minimum criteria.)
- F: 49% and below (Sub-par work. The student fails to complete the assignments.)

## Inclusive Learning Environment

I value the many perspectives that students bring to this class, and I hope we can work together to create a learning community built on open communication, mutual respect, and a sense of belonging. Healthy disagreements and debates are encouraged as part of the learning process, but personal attacks or disrespectful behavior are not acceptable. These expectations are consistent with the UNT Code of Student Conduct (Policy 07.012). Together, we can make this classroom a safe and welcoming space for everyone. If you ever feel that this is not the case, please reach out to me so we can talk about it. We are all learning together.

## Course Policies

### [Attendance Policy]

Attendance is required for all class meetings. Beginning in Week 3, attendance will be formally recorded for each class. Attendance contributes 10 points, or 10% of the total course grade. **Each unexcused absence will result in a deduction of 1 point** from the attendance grade. To qualify as an excused absence, students must **provide official documentation at least 24 hours prior to the absence**, unless it is an emergency covered by the University's excused absence policy. Arriving 15 minutes or more after the start of class will be considered a tardy, and **each tardy will result in a deduction of 0.5 points** from the attendance grade. This policy is consistent with the UNT Student Attendance and Authorized Absences Policy (06.039).

### [Examination Policy]

This course includes **two in-class midterm examinations (Exam 1 and Exam 2)**. Prior to each exam, a review session will be conducted to summarize the covered material and practice problem-solving techniques.

All examinations will be conducted **in person and handwritten** in the classroom. Students are expected to bring **writing materials and a standard engineering calculator**. The use of **unauthorized electronic devices**, including but not limited to **smartphones, laptops, tablets, smartwatches, or other electronic devices**, is **strictly prohibited** during the exams. Only permitted materials may be used.

Any form of **academic dishonesty**, including the use of unauthorized materials or devices, will be considered a violation of academic integrity and will result in an **immediate score of zero for the exam and dismissal from the exam session**, in accordance with university policy.

## [Generative AI (GenAI) Use Policy]

In this course, the use of Generative AI (GenAI) tools such as ChatGPT, Claude, Gemini, or similar platforms is **permitted for learning support**, including clarifying course concepts, reviewing lecture materials, and assisting with understanding problem-solving approaches. This use is encouraged as a way to deepen your understanding and to help you develop skills relevant to modern engineering practice.

However, students are **not permitted to rely on GenAI tools to complete and submit homework assignments in their entirety**. Submitting GenAI-generated content as your own work without substantial understanding and independent effort undermines the learning process and will be considered a violation of academic integrity under the **UNT Student Academic Integrity Policy (Policy 06.003)**. If there is reason to believe that an assignment was generated primarily by GenAI, the instructor reserves the right to request additional verification, such as asking the student to explain their solution process or reasoning.

In line with the UNT Honor Code, all work you submit must ultimately be your own. Responsible and transparent use of GenAI to support your learning is allowed, but unauthorized or unacknowledged reliance on GenAI for graded work will not be tolerated. If you are ever uncertain whether a particular use of GenAI is acceptable, please ask the instructor for clarification before proceeding.

## [Syllabus Change Policy]

This syllabus is subject to change at any time during the semester with changes to be announced in class.

## [Instructor Responsibilities and Feedback]

### *Grade Disputes*

The student is required to wait 24 hours before contacting instructor to dispute a grade. Within that time, the instructor will review the assignment details and reflect on the quality of the work the student turned in.

### *Communication*

Most general questions should go through the Q & A forum in the Discussion Board area. If the student has a private question, he/she can contact the instructor, who should be able to respond within 2 business days (usually sooner).

### *Instructor Feedback on Assignments*

The instructor should return feedback on all assignments within 2 weeks of the due date. If the instructor is unable to return feedback, he will post an Announcement to let everyone know when it can be expected.

# UNT Policies

## [Academic Integrity Policy]

Academic Integrity Standards and Consequences. According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to, cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University. In this course, responsible use of Generative AI tools is addressed in a separate GenAI Use Policy. Unauthorized use of GenAI tools or misrepresentation of work will be treated as an academic integrity violation.

## [ADA Policy]

The University of North Texas makes reasonable accommodations for students with disabilities. To request accommodations, you must first register with the Office of Disability Access (ODA) by completing an application for services and providing documentation to verify your eligibility each semester. Once your eligibility is confirmed, you may request your letter of accommodation. ODA will then email your faculty a letter of reasonable accommodation, initiating a private discussion about your specific needs in the course.
You can request accommodations at any time, but it's important to provide ODA notice to your faculty as early as possible in the semester to avoid delays in implementation. Keep in mind that you must obtain a new letter of accommodation for each semester and meet with each faculty member before accommodations can be implemented in each class. You are strongly encouraged to meet with faculty regarding your accommodations during office hours or by appointment. Faculty have the authority to ask you to discuss your letter during their designated office hours to protect your privacy. For more information and to access resources that can support your needs, refer to the Office of Disability Access website (https://studentaffairs.unt.edu/office-disability-access).

## [Prohibition of Discrimination, Harassment, and Retaliation (Policy 16.004)]

The University of North Texas (UNT) prohibits discrimination and harassment because of race, color, national origin, religion, sex, sexual orientation, gender identity, gender expression, age, disability, genetic information, veteran status, or any other characteristic protected under applicable federal or state law. UNT takes active measures to prevent such conduct and investigates and takes remedial action when appropriate.

## [Emergency Notification & Procedures]

UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (e.g., severe weather, campus closing, and health and public safety emergencies). In the event of a university closure, please refer to Canvas for contingency plans for covering course materials.

## [Retention of Student Records]

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Course work completed via the Canvas online system, including grading information and comments, is also stored securely for one year. Students have the right to view their individual record; however, information about student records will not be divulged to other individuals without proper written consent, in accordance with the Family Educational Rights and Privacy Act (FERPA).

## [Acceptable Student Behavior]

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive. Students engaging in unacceptable behavior will be directed to leave the classroom and may be referred to the Dean of Students. These expectations apply to all instructional forums, including classrooms, labs, discussion groups, and electronic environments. See UNT's Code of Student Conduct (https://deanofstudents.unt.edu/conduct).

## [Access to Information – Eagle Connect]

Students' access point for business and academic services at UNT is located at my.unt.edu. All official communication from the University will be delivered to a student's Eagle Connect account. Please ensure that you check this account regularly or set up forwarding.

## [Student Evaluation Administration Dates (SPOT)]

Student feedback is an essential part of participation in this course. The student evaluation of instruction is required for all organized classes at UNT. The survey will be available during weeks 13–15 of the semester. Students will receive an email from "UNT SPOT Course Evaluations via IASystem Notification" (no-reply@iasystem.org) with the survey link. Once students complete the survey, they will receive a confirmation email. Additional information: http://spot.unt.edu or spot@unt.edu.

## [Sexual Assault Prevention and Title IX]

UNT is committed to providing a safe learning environment free of all forms of sexual misconduct, including sexual harassment, sexual assault, domestic violence, dating violence, and stalking. Federal laws (Title IX and the Violence Against Women Act) and UNT policies prohibit discrimination on the basis of sex. Campus resources, including Survivor Advocates, are available to assist students. Survivor Advocates can be reached at SurvivorAdvocate@unt.edu or 940-565-2648. Alleged sexual misconduct can also be reported to the Title IX Coordinator at oeo@unt.edu or 940-565-2759.

## [Important Notice for F-1 Students Taking Distance Education Courses]

*Not applicable for this in-person course.*

## [Student Verification]

*Not applicable for this in-person course.*

## [Chosen Names]

*Students are welcome to use a chosen name that may differ from their legal name. If you have a chosen name you would like me to use in class, please let me know. UNT provides resources to update your chosen name for class rosters, ID cards, and email accounts. For more information, visit https://edo.unt.edu/chosen-name.*

## [Use of Student Work]

A student owns the copyright for all work (e.g., software, photographs, reports, presentations, and email postings) created in this class. The University is not entitled to use any student work without the student's permission unless specific conditions are met (e.g., the work is used only once, not in entirety, and the student is not identified). If conditions are not met, written permission from the student is required.

## [Transmission and Recording of Student Images]

This course is primarily delivered in person. However, on occasion the instructor may use lecture capture or

other recording technologies for instructional purposes, such as reviewing Colab demonstrations or sharing lecture content with the class via Canvas. Students may occasionally appear on video during these recordings. Recordings will be used only for educational purposes within this course and may be reused in future offerings of the course. If you have concerns about appearing in recordings, please contact the instructor to discuss possible accommodations.

## [Academic Support & Student Services]

*UNT strives to offer a high-quality education in a supportive environment where you can learn, grow, and thrive. As a faculty member, I am committed to supporting you, and I want to remind you that UNT offers a range of mental health and wellness services to help maintain balance and well-being. Utilizing these resources is a proactive way to support your academic and personal success. To explore campus resources designed to support you, check out mental health services (https://clear.unt.edu/student-support-services-policies), visit unt.edu/success, and explore unt.edu/wellness. To get all your enrollment and student financial-related questions answered, go to scrappysays.unt.edu.*