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# ECE 461 / 661: Control Systems (4cr)

Fall 2024

Instructor: Jake Glower  
Contact: jacob.glower@ndsu.edu  
Office Hours: Tu/Th 10-11am (pretty much all day Tu/Th)  
Lecture: MWF, 10AM, ECE 123  
Lab: Room 211, Check Out  
Lab Times: Open Lab (labs are part of the homework sets)  
Web Page: www.BisonAcademy.com

## Bulletin Description

Analysis and design of control systems. Controller design to meet time and frequency specifications. Three 50-min lectures and one 2-hour lab per week. Prereq: ECE 343.

## Course Objectives:

By the end of the semester, students should be able to:

- Determine the differential equation which describes electrical circuits, mass spring systems, and rotational systems
- Determine the transfer function of a system from its differential equation
- Determine how a given system will behave by inspection based upon its dominant poles
- Determine how a feedback control system will behave as the feedback gain changes using root locus techniques,
- Design single-loop feedback control systems for a dynamic system using root locus and frequency domain techniques

## Evaluation Procedure and Criteria:

There will be three midterms, homework and labs throughout the semester, and a final exam. Your total grade will be the average of these as follows:

- Midterms: 1 unit each
- Homework & Labs 1 unit
- Final 2 units
- Total: Average of all above

Final grades will be based upon the average of these as:

- A = 90% or more
- B = 80% to <90%
- C = 70% to <80%
- D = 60% to <70%
- F = <60%

Grading will be on a straight scale to encourage working together. My objective is to see that everyone learns the material. If the class studies together and everyone gets a 90% average, I'd gladly give all A's. (After all, your competitors are at schools like UCLA, Michigan, etc. - they're not your classmates.)

A student may take a makeup exam if he/she misses an exam due to an emergency, illness, or plant trip and notifies me in advance of the exam. Late homework will not be accepted once the solutions are posted online. All questions on the grading of a particular exam must be resolved within a week of returning the exam.

## Hy-Flex Model for Fall 2024

Students are welcome to take this course however they like:

- In-Person: Students are welcome to attend class at the designated class time and location. Note that face masks are required for everyone.
- Live-Stream: Students are also welcome to live-stream the class. A link with how to connect will be sent out at the start of the semester on BlackBoard and to your NDSU email address.
- On-Line: Students are also welcome to take the class on-line and fit lectures into their own schedule.

Everyone is welcome to use the on-line resources on Bison Academy. These include

- Each day's lecture,
- Detailed lecture notes for each day,
- YouTube videos for each lecture, and
- Solutions to previous homework sets (which are usually similar to this semester's homework)

In addition, midterms and the final will be offered both in-class as well as remotely through BlackBoard. If you opt for BlackBoard, you will typically be allowed to start any time between 8am and midnight the day of the test. Once you start the test on-line, you have 2 hours to complete the test, 3 hours to complete the final exam.

It's completely your choice how you take the class.

## PLC Labs

The first three weeks use PLCs for the labs. You can use

- Allen Bradley Micro810 PLC's, or
- PLCTwiddle.com: On-line (free) PLC simulator.

The advantage of the Allen Bradley PLC's is that there are a large number of jobs related to PLC programming - and most PLC's in the U.S. are Allen Bradley. This lets you get use to the software for Allen Bradley and put that on your resume. We (ECE) have ten Micro810 PLC's you can check out to complete the PLC assignments (homework #1 - #3). With only 27 people registered, we should be able to give each person time on an Allen Bradley PLC.

PLC Fiddle is a free PLC simulator that is very similar to Allen Bradley's software. It's free and lets you write ladder logic programs and test them without the hardware.

Either approach is OK for this class. My goal is to expose you to PLC's. It's nothing you haven't already seen - just the syntax is a little different.

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## Feedback Control Labs

Two build and test feedback controllers we design in the last 14 weeks of the semester, three software packages can be used:

- Simulink: Part of the Matlab tool suite NDSU has a site license for
- VisSim: A very nice graphical drag and drop program to build control systems,
- CircuitLab: It looks like CircuitLab can do this too but I haven't figured it out yet...

Most homework assignments will ask you to design a feedback control system to meet certain design criteria. Simulink and VisSim are nice packages that let you do that. Plus, they're free for NDSU students.

## Required Student Resources:

- Calculator capable of complex numbers
  - HP35 Prime (\$184 from Amazon)
  - Free42 (free app for your cell phone)
  - Most ECE students use TI84 Plus (\$100 from Amazon)
- Matlab
  - Free for NDSU students

## Legal Stuff:

**Attendance:** Attendance on class days where there is not a test is optional but highly recommended. Attendance during days of an exam are required except for valid excuses. Note that all lecture notes, homework sets, and solutions are available on-line at [www.BisonAcademy.com](http://www.BisonAcademy.com) Please review this material before class. That will allow more class time to be spent on answering questions and explaining difficult concepts.

**Special Needs** - Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the Disability Services Office ([www.ndsu.edu/disabilityservices](http://www.ndsu.edu/disabilityservices)) as soon as possible.

**Academic Honesty** - The academic community is operated on the basis of honesty, integrity, and fair play. NDSU Policy 335: Code of Academic Responsibility and Conduct applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the Office of Registration and Records. Informational resources about academic honesty for students and instructional staff members can be found at [www.ndsu.edu/academichonesty](http://www.ndsu.edu/academichonesty).

**Academic Honesty Defined:** All written and oral presentations must "respect the intellectual rights of others. Statements lifted verbatim from publications must be cited as quotations. Ideas, summaries or paraphrased material, and other information taken from the literature must be properly referenced" (Guidelines for the Presentation of Disquisitions, NDSU Graduate School).

**ECE Honor Code:** On my honor I will not give nor receive unauthorized assistance in completing assignments and work submitted for review or assessment. Furthermore, I understand the requirements in the College of Engineering Honor System and accept the responsibility I have to complete all my work with complete integrity.

**Veterans and Student Soldiers:** Veterans and student soldiers with special circumstances or who are activated are encouraged to notify the instructor in advance.

**Attendance:** According to NDSU Policy 333 ([www.ndsu.edu/fileadmin/policy/333.pdf](http://www.ndsu.edu/fileadmin/policy/333.pdf)), attendance in classes is expected. Students are responsible for the material covered in class and in assignments regardless of their attendance.