ELEN 471 – Automatic Control Systems

Instructor: Dr. Lingxiao Wang
Lecture room: BOGH 328
Lecture hours: 11:00 am – 12:15 pm MWF
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Office: NETH 213
Office hours: 2:00 pm – 4:00 pm Monday to Friday
Prerequisites: ELEN 321, MATH 244

Course Description:

1. Control system modeling and transfer function calculation.
2. System analysis in both time-domain and frequency-domain.
3. Controller design for linear time-invariant feedback control systems.

Specific Course Outcomes: Students completing this course should be able to:

1. Analyze automatic control systems and design such systems using proportional, integral, and derivative (PID) controllers. [SO-1]
2. Draw signal-flow graphs and use Mason's rule to determine transfer functions of feedback systems. [SO-1]
3. Determine the A, B, C, and D matrices for state-variable models of systems. [SO-1]
4. Calculate the steady-state errors and analyze the sensitivity of feedback control systems. [SO-1]
5. Determine the performance characteristics, such as percent overshoot and settling time, of second-order control systems. [SO-1]
6. Determine the stability of systems. [SO-1]
7. Use MATLAB to analyze and design feedback control systems. [SO-1, SO-2, SO-7]

Textbook: R.C. Dorf and R.H. Bishop, *Modern Control Systems*, 13th edition, Pearson Prentice Hall, Upper Saddle River, NJ, 2016.

Recommended Software: MATLAB Student Version + Control Systems Toolbox

Homework:

1. Homework due dates are 1 week after the post date (You can find the post date on the schedule table).
2. Homework should be submitted online on the Canvas.
    a. Download homework questions on the Canvas and print them out.
    b. Complete homework questions.
    c. Scan your completed homework questions and upload them on Canvas.

3. Handwriting should be clear and recognizable.
4. Use standard homework papers.
5. Some homework may require computer simulation using MATLAB.

Exams:

1. There will be four in-class exams given during the course.
2. Exams are individual tasks (no collaborations)
3. Exams are open-note (4 letter-paper size paper notes allowed, front and back sides).
4. You can bring a calculator and use MATLAB.
5. No make-up exams will be permitted unless approval is obtained from the instructor prior to the scheduled examination.

Grading: The weighting of grades is as follows:

- Homework – 30%
- Exam 1 – 15%
- Exam 2 – 15%
- Exam 3 – 15%
- Exam 4 – 15%
- Attendance (6 random roll calls throughout the semester) – 10%

Grading Scale: The grading scale used for this course is shown below:

- A – 100-90%
- B – 89.99-80%
- C – 79.99-70%
- D – 69.99-60%
- F – below 60%

Class Attendance: This class will adhere to the guidelines for class attendance found in Chapter 3 of the University Catalog, available online at www.latech.edu/registrar/bulletin/. Additionally, attendance will be taken promptly at the beginning of class and any student arriving after attendance has been checked without a reasonable excuse will be considered absent. Reasonable excuses DO NOT include routine doctor visits, car trouble, parking difficulties, oversleeping, or work schedules. Any student who misses three or more classes without university approved excuses may be penalized at the instructor's discretion.

Emergency Class Disruption Policy: In the event that a disaster or other emergency results in campus closure, this course will continue via Moodle and Zoom. You will be required to login to moodle.latech.edu for further instructions. Please enroll in the Emergency Notification System (instructions below) to receive official campus updates. You may also refer to ert.latech.edu for updated information.

Disability Disclosure: Students needing testing or classroom accommodations based on a disability are encouraged to discuss those needs with the instructors as soon as possible. For more information about eligibility for accommodations, contact the Department of Testing and Disability Services, 318-257-4221, www.latech.edu/ods for assistance.

Academic Misconduct: Academic behavior is governed by university policies and guidelines found in Chapter 4 of the University Bulletin. It is the student's obligation to be familiar with and understand these policies, regulations, and guidelines.

- Behavior: Students are expected to maintain a professional classroom environment. Students are to refrain from: verbal or physical violence, threats, improper language, disrespect to classmates and the instructor. Participants of such activities will be asked to leave the class. If you are removed from class for behavioral reasons, you will be considered absent for that class period.
- Cheating: Cheating of any kind will not be tolerated. Collusion during examinations through verbal or electronic communication and/or plagiarism of any kind throughout the course will result in a zero grade for the assignment or exam as well as notification of the proper university officials. Multiple infractions will result in a zero grade for the course.

Emergency Notification System: All Louisiana Tech students are strongly encouraged to enroll and update their contact information in the Emergency Notification System. It takes just a few seconds to ensure that you are able to receive important text and voice alerts in the event of a campus emergency. For more information on the Emergency Notification System, please visit www.latech.edu/administration.ens.shtml.

COVID -19 Information: Students can access COVID-19 related information, guidelines, FAQs, and policies at Louisiana Tech's website: www.latech.edu/coronavirus.
Louisiana Tech's Return to Campus Plan is located at www.latech.edu/return-to-campus. Masks are required to be worn indoors on campus. Masks are required to be worn outdoors if six feet of physical distance cannot be maintained. Every member of the Tech Family will need to take personal responsibility for their behavior, which includes wearing masks, maintaining physical distancing, washing hands regularly, using proper sneeze and cough practices, helping maintain clean academic and office areas, and monitoring for symptoms of COVID-19.
The direct link to the reporting protocol for students is located at www.latech.edu/return-to-campus-plan/for-students/. Students can reach out to Stacy Gilbert, Dean of Student Services & Academic Support, at stacyc@latech.edu for help with accommodations and additional information.
Failure to comply with Safety Protocols listed in the "Back to Campus Fall 2020" booklet, located at www.latech.edu/documents/2020/07/covid-return-book.pdf/, specifically on pages 5-7 about masks and social distancing, could result in students being in violation of the Classroom Behavior Policy listed on page 125 of the "Student Handbook," located at www.latech.edu/documents/2018/09/student-handbook.pdf/.

Information and contact numbers and sites for Louisiana Tech Counseling Services are located at https://www.latech.edu/current-students/student-advancement-affairs/counseling-services/.

Tentative Course Schedule

Class	Day	Date	Topic	HW Post	HW Due
1	Fri	Sep. 6th	Syllabus and Introduction to Control Systems		
2	Mon	Sep. 9th	Mathematical Models of Systems and Linearization (CH2)		
3	Wed	Sep. 11th	The Laplace Transform and Transfer Functions (CH2)		
4	Fri	Sep. 13th	Block Diagrams, Signal-Flow Graph, and Mason's Formula I (CH2)	1	
5	Mon	Sep. 16th	Block Diagrams, Signal-Flow Graph, and Mason's Formula II (CH2)		
6	Wed	Sep. 18th	State Variable Models (CH3)		
7	Fri	Sep. 20	The Transfer Function from the State Equation (CH3)	2	1
8	Mon	Sep. 23rd	Controllability and Observability (CH11)		
9	Wed	Sep. 25th	Review		
10	**Fri**	**Sep.27th**	**Exam 1 (11:00am – 12:15pm)**		2
11	Mon	Sep. 30	Tracking Error Signal Analysis in Feedback Control Systems (CH4)		
12	Wed	Oct. 2nd	Sensitivity to Parameter Variation, Disturbance Rejection (CH4)	3	
13	Fri	Oct. 4th	Transient and Steady State Response (CH4)		
14	Mon	Oct. 7th	Second Order Systems (CH5)		
15	Wed	Oct.9th	Steady State Error Analysis (CH5)	4	3
16	Fri	Oct.11th	Review		
17	**Mon**	**Oct. 14th**	**Exam 2 (11:00am – 12:15pm)**		
18	Wed	Oct. 16th	Stability of Linear Systems (CH6)		4
19	Fri	Oct. 18th	Routh-Hurwitz Stability Test (CH6)		
20	Mon	Oct. 21st	Stability of State Variable Systems (CH6)	5	
21	Wed	Oct. 23rd	Root Locus Method Introduction (CH7)		
22	Fri	Oct.25th	Root Locus Procedure (CH7)		
23	Mon	Oct.28th	PID Controller (CH7)	6	5
24	Wed	Oct.30	Review		
25	**Fri**	**Nov.1st**	**Exam 3 (11:00am – 12:15pm)**		
26	Mon	Nov.4th	Frequency Response Methods (CH8)		6
27	Wed	Nov.6th	Nyquist Criterion (CH9)		
28	Fri	Nov.8th	Gain Margin and Phase Margin (CH13)	7	
29	Mon	Nov. 11th	Review		
30	**Wed**	**Nov.13th**	**Exam 4 (11:00am – 12:15pm)**		
31	Fri	Nov. 15th	No Meeting		7