Tennessee Technological University
Department of Electrical and Computer Engineering
ECE 6200-001: Linear Systems Analysis
Fall 2025

Instructor:

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Office hours**:** Tu 1:00 PM – 2:30 PM, W 2:30 PM – 4:00 PM, or by appointment

Textbook: Chi-Tsong Chen, *Linear System Theory and Design*, Fourth Edition, Oxford, New York, 2013.

Class Time and Place: Tu and Th, 3:00 PM – 4:15 PM, Brown Hall 314

Course Description:

Welcome to ECE 6200: Linear Systems Analysis. Many real-world systems exhibit behavior that is linear when operated in a prescribed range of interest. The primary motivation of dealing with such systems is that their analysis and design are mathematically tractable owing to the availability of solid theoretical tools to support them. From control theory standpoint, linear systems offer a significant freedom to design controllers which can be readily used to manipulate the behavior of these systems towards improving their performance. Such systems find applications in areas as diverse as engineering, computing, medicine, economics, operations research, and social sciences. ECE 6200 – Linear Systems Analysis is aimed as a first-year graduate course that provides a comprehensive treatment of the analysis of linear systems by introducing students to the general theoretical results from linear systems theory. These results not only provide a conceptual framework towards the analysis of linear systems but also form the basis of understanding linear control design tools. While the subject has solid mathematical foundations laid by control theory, an important goal of this course is to equip the students with the ability to analyze and solve practical real-world control problems using case studies and projects.

Topics Covered:

1. Introduction to linear systems: Basic terminologies, signals and systems classifications, linearity, superposition principle, properties of systems, real-world examples, case study, etc.
2. Mathematical description of LTI systems: Various mathematical formulations, impulse response description, transfer functions, ordinary differential equations, state-space form, linearization, models of electric circuits, mechanical or electromechanical systems, case study, etc.
3. Review of linear algebra: Vector spaces, matrix theory, norms, linear independence, similarity transformations, special forms, matrix functions, Cayley-Hamilton theorem, quadratic forms, SVD, useful matrix relations, etc.
4. Solution of state-space equations: discrete-time and continuous-time solutions, state and

output response, matrix exponential, equivalency of state-space equations, state-space realization, etc.

5. Stability analysis: Definitions, notions of stability, necessary and sufficient conditions, BIBO stability, internal stability, Lyapunov analysis, discrete-time and continuous-time results, case study, etc.
6. Controllability and observability analysis: fundamental concepts, necessary and sufficient conditions, controllability-observability duality, indices, conditions for Jordan forms, Kalman decomposition, case study, etc.
7. Control design and state estimation: state feedback control, eigenvalue assignment, stabilization, state observer/estimator design, reduced-order observer, separation principle, output feedback control, case study, etc.

Primary Teaching Method:

Classroom lectures

Homework:

Assignments will be assigned frequently. Please make sure that your writing is neat and clear, and that you have expressed your reasoning, not just the final answers.

Grading:

Assignments (20%), Test 1 (15%), Test 2 (15%), Project (25%), Take Home Final (25%)

Course Objectives:

1. Understanding of various mathematical descriptions of linear systems
2. Ability to apply linear algebra for the state-space analysis of linear systems
3. Knowledge of qualitative analysis such as stability, controllability, and observability
4. Learn control design tools such as state / output feedback methods to design controllers
5. Apply the control analysis and design techniques to solve real-world control problems

Attendance Policy:

Attendance will be observed. Students are expected to attend the lectures and are responsible for the topics covered in class.

Student Academic Integrity Policy:

Maintaining high standards of academic integrity in every class is critical to the reputation of Tennessee Tech, its students, faculty, alumni, and the employers of Tennessee Tech graduates. Academic integrity is at the foundation of the educational process and the key to student success. Students with academic integrity are committed to honesty, ethical behavior, and avoiding violations of academic integrity. All students are required to read and understand Policy 216:

Student Academic Integrity. Please see the Academic Integrity website (https://www.tntech.edu/provost/academicintegrity/) for more information.

Instructional and Assignment Use of Artificial Intelligence:

AI is not permitted for any use within this course. For details, see the policy details on https://www.tntech.edu/citl/ai-syllabus-statements.php

Disability Accommodation:

Students with a disability requiring accommodations should contact the accessible education center (AEC). An accommodation request (AR) should be completed as soon as possible, preferably by the end of the first week of the course. The AEC is located in the Roaden University Center, room 112; phone 931-372-6119. For details, view Tennessee Tech's policy 340 – services for students with disabilities at policy central.

Communication Policy:

The use of communication or recording/playback devices, with the exception of devices explicitly permitted by the course instructor, is prohibited during tests and examinations. This includes, but is not limited to, cell phones, PDAs, iPods and MP3 players, tablets, computers, cameras, and headphones or in-ear earphones. All such devices must be turned off and put away in an inaccessible location such as a backpack. Accessing a prohibited device will result in the immediate termination of the quiz or examination and may result in a charge of academic misconduct.

Additional Resources

Technical Help:

If you are experiencing technical problems, visit the myTech IT Helpdesk for assistance.

If you are having trouble with one of the instructional technologies (i.e. Zoom, Teams, Qualtrics, Respondus, or any technology listed here)visit the Center for Innovation in Teaching and Learning (CITL) website or call 931-372-3675 for assistance.

Tutoring:

The university provides free tutoring to all Tennessee Tech students through the Learning Center within the Volpe Library. Tutoring is available for any class or subject, as well as writing, test prep, study skills, and resume support. Appointments are scheduled, so contact the Learning Center website for more information.

Counseling and Health Services:

Tennessee Tech offers support for student well-being through two key services. The Center for Counseling and Mental Health Wellness provides brief, solution-focused therapy to help students

navigate personal and social challenges. Health Services delivers accessible, high-quality, and affordable medical care to promote overall wellness. Visit their respective websites to learn more or schedule an appointment.

Emergency Preparedness Protocols:

Each student must take personal responsibility for following any University protocol related to pandemics, natural disasters, and other public health and safety events. Students are expected to follow all directives published by Tennessee Tech on its Environmental Health & Safety webpage.