System Dynamics and Vibrations

Course Information

Instructor: Yongxin Chen (yongchen@gatech.edu)

Course Prefix and Number: AE 3530 CHE

Term: Fall 2026

Course Description

To teach students basic mathematical tools (Differential equations, Laplace transformation and State space models) to model and analyze dynamic systems in various engineering disciplines (Mechanical, Electrical, Aerospace etc).

Course Learning Outcomes

1. Understand the concept of dynamical systems.
2. Master differential equation approach to dynamical system modeling.
3. Master Laplace transformation approach to dynamical system modeling.
4. Master state space approach to dynamical system modeling.
5. Be able to analyze the behavior of dynamical systems, in both time-domain and frequency-domain.
6. Be able to model and understand multi-degrees-of-freedom systems.
7. Get ready for AE 3531: Control System Analysis and Design.

Required Course Materials

1. (required) *System Dynamics* by K. Ogata, 4th Edition
2. (optional) *System Dynamics* by William Palm, 3rd Edition
3. (optional) *Introduction to Structural Dynamics and Aeroelasticity* by Hodges and Pierce
4. (optional) *Flight Stability and Automatic Control* by Robert Nelson

Grading Policy

This course is graded on a letter grade basis.

The grade will be assigned based on agreed upon objectives commensurate with the difficulty and scope of the project, the number of credit hours, as well as the technical proficiency of the student. It is the joint responsibility of the instructor and the student to discuss expectations and how meeting or not the expectations affects the final grade. The grading process will be clearly articulated to the student to allow reasonable prediction progress towards the final grade throughout the semester.

- There will be about 8 sets of homework problems.
- There will be two midterm exams (tentatively on Sep 29 and Nov 03). There will be one cumulative final exam (Dec 05).
- All students are expected to attend the exams. There will not be any make-ahead or make-up exams. If you have a situation that you feel will prohibit your attendance for an exam, e.g.,

attendance at an immediate family member's wedding, death, etc., please consult with the instructor as soon as possible after the beginning of the academic term to discuss.

- Contact your TA for questions regarding your grading. If there is any mistake in grading, the student have to contact the TA within two weeks after the grade is out. After two weeks, no more changes on the grades can be made.
- No more changes on existing grades for both exams and homework can be made after Dec 04.
- The overall distribution of grades is as follows:

Homework	40%
2 Midterms	30%
Final	30%

- Final letter grade will be assigned following the table below

Precentage	Grade
90 - 100	A
80 - 89.9	B
65 - 79.9	C
50 - 64.9	D
< 50	F

Attendance Policy

Class attendance is mandatory. Each student will be responsible for obtaining notes and homework assignments for the days she/he will miss. No cell-phones, no eating, no reading newspapers, magazines, etc or other material which are not related to the class are allowed.

Academic and Research Honesty/Integrity Statement

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review the Student Code of Conduct and the Academic Honor Code, especially Appendix A: Graduate Addendum to the Academic Honor Code.

Students are expected to perform research in an ethical and responsible manner. All Doctoral and Master's Thesis students are required to take the Responsible Conduct of Research training, and it is expected that students abide by the principles taught in that training while performing research.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

Allegations of scientific or scholarly misconduct are handled in accordance with the procedures outlined by the Policy for Responding to Allegations of Scientific or Other Scholarly Misconduct.

Core IMPACTS

Not applicable

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulates some basic expectations that you can have of me and that I have of you. Additional information for research-related work is given in The Expectations of Advisors and Advisees. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Outlines

1 Modeling of Dynamic Systems - Ogata Chapter 1,3,6,7 (6 lectures)
   - Introduction to dynamic systems
   - Differential equations review
   - Mechanical systems
   - Electrical systems
   - Electromechanical systems

2 Laplace Approach to System Modeling - Ogata Chapter 2, 4 (6-7 lectures)
   - Math background
   - Laplace Transform
   - Transfer function
   - Block diagram

3 State Space Approach to System Modeling - Ogata Chapter 5 (3 lectures)
   - Linear algebra review
   - State space model
   - Connections between the three representations of system models

4 Time domain analysis of dynamic systems - Ogata Chapter 8 (3-4 lectures)
   - Transient response of first order systems
   - Transient response of second order systems
   - Solutions of linear time-invariant systems
   - Stability of dynamic systems

5 Frequency domain analysis of dynamic systems - Ogata Chapter 9, 11 (3-4 lectures)
   - Frequency response
   - Bode diagram
   - Vibration isolation and absorbers

6 Multi-degrees-of-freedom systems - Ogata Chapter 9, Hodges Chapter 3 (3-4 lectures)
   - Multi-degrees-of-freedom systems
   - Uniform string vibration
   - Torsional vibrations of beams