ME6402 - Nonlinear Control Systems (3-0-3)
George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology

Instructor:	Maegan Tucker
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Inquiry Room:	TSRB 442
Inquiry Hours:	Tuesday 4pm-5pm (https://gatech.zoom.us/j/9256120304)
	Friday 10am-11am (https://gatech.zoom.us/j/9256120304)
Prerequisite:	ME 6401 or equivalent (linear systems).
	Either MATLAB or Python experience is advisable.
Course Book:	Hassan Khalil, Nonlinear Systems, 3rd edition
	Purchase not required. (Lecture notes will be provided)
Optional Refs:	Shankar Sastry, Nonlinear Systems: Analysis, Stability and Control.

Catalogue Description: Analysis of nonlinear systems, geometric control, variable structure control, adaptive control, optimal control, applications.

Scope and Goals: To be familiar with the theory and applications of nonlinear systems (phase plane, describing functions, Lyapunov methods), geometric control, variable structure control, adaptive control, applications to robots and spacecraft, and nonlinear optimal control.

Course Mechanics and Grading: The course meets two times a week, TuTh 2:00-3:15PM in Instructional Center 209.

The course grading criteria consist of the following components whose percentage of the total grade calculation is also given,

	Homework (6)	Midterm	Final
Percent of Final Grade	30%	30%	40%

where the contributions are based on total points per category (e.g., total points for homework).

Homeworks. Homework will be assigned approximately every third week. These homework assignments will be due on Friday (11:59pm). All material should be submitted virtually on Gradescope via Canvas.

All students are automatically given three days for extensions. These days can be broken up in any way. For example, three assignments can be handed in one day late each, or one assignment can be handed in three days late, or any other combination. Once your three extension days have been used, homeworks can be submitted up to 72 hours late, without request, for a 20% penalty per 24 hours. After 72 hours, solutions for the homework will be posted. Once the solutions are posted, late homework will not be accepted. For any other extensions, or unusual circumstances, please make sure to contact me prior to the solutions being posted.

While collaboration is encouraged regarding the homework material, all work to be turned in is expected to be individually completed. It is presumed that we are all operating under the Georgia Tech Honor Code.

Exams. There will be one midterm exam and one final exam. The midterm exam will be held on February 25th and the final exam will be held on April 29th. The exams will be given in class. For distance-learning students, the exams will be a timed take-home exam.

No make-up exams will be given without prior approval. In case of a documented emergency, the Dean of Students will contact the instructor on the student's behalf (please see the excused absences section below).

Communication. I will typically make an effort to be available for a short period after class for any questions that may arise. You should also feel free to e-mail me if homework statements are unclear or to set up an alternative time to meet, however please be sure to include the string "ME6402" in the subject heading.

Excused Absences. In the event of a medical emergency or an illness that is severe enough to require medical attention, students are responsible for contacting the Office of the Dean of Students as soon as possible to report the medical issue or emergency, providing dated documentation from a medical professional and requesting assistance in notifying their instructors. The medical documentation will be handled confidentially within the Office of the Dean of Students and will inform a decision as to whether communication with instructional faculty is appropriate. It is the expectation of the Institute that instructional faculty will honor a request from the Office of the Dean of Students to excuse a medical emergency or illness and allow make-up of the work missed, including homeworks, quizzes, presentations, examinations, or other class assignments.

Course Schedule (subject to change):

Week	Date	Lecture	Assignment Due
		Course Schedule	
1	January 7	1. Nonlinear Systems: A Brief Introduction	
	January 9	2. Essentially Nonlinear Phenomena	
2	January 14	3. Periodic Orbits in the Plane	
	January 16	4. Periodic Orbits in the Plane Continued	
3	January 21	5. Bifurcations	
	January 23	6. Center Manifold Theory	HW 1
4	January 28	7. Mathematical Background	
	January 30	8. Existence and Uniqueness Theorems for ODEs	
5	February 4	9. Lyapunov Stability Theory	
	February 6	10. LaSalle-Krasovskii Invariance Principle	HW 2
6	February 11	11. Lyapunov's Linearization Method	
	February 13	12. Time-Varying Systems Continued	
7	February 18	13. Time-Varying Systems and Lyapunov Design	
	February 20	14. Backstepping	HW 3
8	February 25	– Midterm Exam (In Class) –	
	February 27	15. Input-to-State Stability	
9	March 4	16. Feedback Linearization	
	March 6	17. Feedback Linearization (continued)	
10	March 11	18. Full-State Feedback Linearization	
	March 13	19. Full-state Feedback Linearization (cont.)	HW 4
11	March 18	– Spring Break –	
	March 20	– Spring Break –	
12	March 25	20. Control Lyapunov Functions	
	March 27	21. A Brief Introduction to Convex Optimization	
13	April 1	22. Important Classes of Convex Optimization Problems	
	April 3	23. Barrier Functions	HW 5
14	April 8	24. Control Barrier Functions	
	April 10	25. High-Order Control Barrier Functions	
15	April 15	26. Hybrid Systems and Zero Dynamics	
	April 17	27. Control Lyapunov Functions for Hybrid Systems	HW 6
16	April 22	Final Exam Review	
	April 29	– Final Exam –	