EE 5323- Nonlinear Control Systems

COURSE SYLLABUS AND ADMINISTRATIVE POLICY

Instructor: Frank L. Lewis
Updated: Saturday, September 08, 2018 by F.L. Lewis

This is a UTA Web-Based Course. The internet URL is http://www.uta.edu/utari/acs
Related webpages:
   Systems and Controls Thrust Area
   EE 5323 Homepage

UT Arlington Honor Code

I pledge, on my honor, to uphold UT Arlington’s tradition of academic integrity, a
tradition that values hard work and honest effort in the pursuit of academic
equality.

I promise that I will only submit work that I personally create or contribute to group
collaborations, and reference any work from other sources. I will follow the highest
standards of integrity and uphold the spirit of the Honor Code.

Catalog Information: EE 5323 Nonlinear Control Systems. Analysis and design of nonlinear
systems. This is a general course in nonlinear systems with examples from multiple engineering
and science disciplines. Topics include phase planes, Lyapunov theory, describing functions,
iterative maps, chaos and fractals, and nonlinear optimization methods.

Prerequisite: Prerequisite knowledge: EE 5307 or its equivalent is highly recommended.

Course Objectives: To provide students with knowledge and abilities to analyze and design
nonlinear control systems. To understand the use of classical nonlinear techniques such as phase
plane, describing functions. To lay a firm foundation in Lyapunov Theory, feedback linearization,
and backstepping for future work. To study complex chaotic systems and their appearance in
natural and manmade feedback systems. To train students in the use of MATLAB for system
design and simulation for the workplace.

Topics Covered: see separate course outline.

Class hours: TTh 330-450 pm, room NH 202

Instructor: F.L. Lewis, tel: 272-5972, office: UTARI room 215 (off campus), lewis@uta.edu
UTA Faculty Profile: https://www.uta.edu/profiles/dr-frank-lewis
Office hours: before class by request or after class
Teaching Assistant: Victor Lopez    victor.lopezmejia@mavs.uta.edu
Office hours – see Blackboard

Texts:

J.J.-E. Slotine and W. Li, Applied Nonlinear Control, Prentice-Hall
Strogatz, Nonlinear Dynamics and Chaos, Westview Press
Verhulst, Nonlinear Differential Equations and Dynamical systems, Springer-Verlag
Student Edition of MATLAB.

Grading:

Homework-- 20%
Exam 1 (1 sheet of notes both sides) 25%
Exam 2 (2 sheets of notes both sides) 25%
pop quizzes in class 10%
Final Project Report- conference paper 20%    in IEEE Format

The instructor reserves the right to make appropriate changes to the grading policy.

Submission of Homeworks and Posting of Solutions:
Homeworks and exams should be submitted to the GTA through Blackboard online. Solutions will also be posted on Blackboard.

Student Learning Outcomes:

1. Understand nonlinear system analysis and design tools based on Jacobian linearization and the phase plane.
   Assessment- homework design projects and examinations.
2. Understand nonlinear system analysis and design tools based on modern Lyapunov methods, feedback linearization, backstepping.
   Assessment- homework design projects and examinations.
3. Ability to perform designs with various nonlinear control tools using MATLAB computer simulation toolboxes.
   Assessment- computer design and simulation projects assigned in homeworks.
4. Understand the mechanisms of chaos in complex systems and how it arises, and understand analysis techniques for complex systems.
   Assessment- design and simulation projects in homeworks, exams.
5. Understand the context of control systems design including the history of control and ethical responsibilities of engineers.
   Assessment- general performance in class and final project report.
6. Learn to perform a survey and literature search and prepare a research paper with a unified presentation and exposition on a selected topic.
**Assessment- Final Project Report.**

**Relation to Program Objectives.** This is a course in nonlinear systems theory including analysis and design. Classical methods will be developed including phase plane and describing functions. Modern analysis methods include Lyapunov theory, backstepping, feedback linearization. Examples will be studied from aircraft systems, industrial and computer processes, and robotics. New ideas in complex and chaotic systems will be presented, including bifurcations and strange attractors.

**Attendance** is not mandatory. However, it is more fun for me to teach to a full class. If attendance begins to tail off, I will start giving pop quizzes in class.

If you skip classes, you will find the homework and exams more difficult. Due to the pace of the lectures, copying someone else's notes may be an unreliable way of making up an absence. You are responsible for all material covered in class regardless of absences. **If you skip class, please do not ask questions next time about the material you missed. If you attend class, questions are always encouraged.**

You will need to use MATLAB, including the neural network, controls, and DSP toolbox. MATLAB is installed on the ACS network. Using the Student Edition of MATLAB you can install it on your own PC or MAC.

Check the **grading of the exams** thoroughly. You will have one week after the exam to see the GTA for re-grading. After this period, the grade is final.

**Questions** during class are strongly encouraged. The worst thing I can do is move too slowly and bore you. The next worst thing I can do is move too quickly and confuse you. If either of these occurs, it is your responsibility to speak up. You are paying for an education, and if the material is not presented clearly with confusion being eliminated shortly after it sets in you are not getting what you contracted for. On the other hand, if I never confuse you I am being unduly conservative and hence not conscientious. There is a very fine balance here, with you as student and me as instructor each having very definite responsibilities for keeping open all channels of communication. It is extremely difficult to teach a course without some sort of real-time feedback.

**Some philosophy.** I have an attitude toward learning which is based very heavily on independence and self-reliance; it can be summed up in the statement

"Knowledge cannot be given, but comes only with great personal sacrifice and effort."

It is my job to make knowledge available to you and show you one attitude toward it based on my experience in the area. It is your job to make it a part of yourself and so your own personal possession.

**General UTA Policy**

**Attendance:** At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator in student success. Each faculty member is free to develop his or her own methods
of evaluating students’ academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, my attendance policy is detailed above. However, while UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients “begin attendance in a course.” UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Blackboard. This date is reported to the Department of Education for federal financial aid recipients.

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. **Students will not be automatically dropped for non-attendance.** Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information, contact the Office of Financial Aid and Scholarships ([http://wweb.uta.edu/aao/fao/](http://wweb.uta.edu/aao/fao/)).

Disability Accommodations: UT Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including The Americans with Disabilities Act (ADA), The Americans with Disabilities Amendments Act (ADAAA), and Section 504 of the Rehabilitation Act. All instructors at UT Arlington are required by law to provide “reasonable accommodations” to students with disabilities, so as not to discriminate on the basis of disability. Students are responsible for providing the instructor with official notification in the form of a letter certified by the Office for Students with Disabilities (OSD). Only those students who have officially documented a need for an accommodation will have their request honored. Students experiencing a range of conditions (Physical, Learning, Chronic Health, Mental Health, and Sensory) that may cause diminished academic performance or other barriers to learning may seek services and/or accommodations by contacting:

**The Office for Students with Disabilities, (OSD) [www.uta.edu/disability](http://www.uta.edu/disability) or calling 817-272-3364.** Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at [www.uta.edu/disability](http://www.uta.edu/disability).

**Counseling and Psychological Services, (CAPS) [www.uta.edu/caps/](http://www.uta.edu/caps/) or calling 817-272-3671** is also available to all students to help increase their understanding of personal issues, address mental and behavioral health problems and make positive changes in their lives.

**Non-Discrimination Policy:** The University of Texas at Arlington does not discriminate on the basis of race, color, national origin, religion, age, gender, sexual orientation, disabilities, genetic information, and/or veteran status in its educational programs or activities it operates. For more information, visit [uta.edu/eos](http://uta.edu/eos).

**Title IX Policy:** The University of Texas at Arlington (“University”) is committed to maintaining a learning and working environment that is free from discrimination based on sex in accordance with Title IX of the Higher Education Amendments of 1972 (Title IX), which prohibits discrimination on the basis of sex in educational programs or activities; Title VII of the Civil Rights Act of 1964 (Title VII), which prohibits sex discrimination in employment; and the Campus Sexual Violence Elimination Act (SaVE Act).
Sexual misconduct is a form of sex discrimination and will not be tolerated. For information regarding Title IX, visit www.uta.edu/titleIX or contact Ms. Jean Hood, Vice President and Title IX Coordinator at (817) 272-7091 or jmhood@uta.edu.

**Academic Integrity:** Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

> I pledge, on my honor, to uphold UT Arlington’s tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.

> I promise that I will submit only work that I personally create or contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

UT Arlington faculty members may employ the Honor Code in their courses by having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System Regents’ Rule 50101, §2.2, suspected violations of university’s standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student’s suspension or expulsion from the University. Additional information is available at https://www.uta.edu/conduct/.

**Lab Safety Training:** Lab Safety Training is not required for this course.

**Electronic Communication:** UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

**Campus Carry:** Effective August 1, 2016, the Campus Carry law (Senate Bill 11) allows those licensed individuals to carry a concealed handgun in buildings on public university campuses, except in locations the University establishes as prohibited. Under the new law, openly carrying handguns is not allowed on college campuses. For more information, visit http://www.uta.edu/news/info/campus-carry/.

**Student Feedback Survey:** At the end of each term, students enrolled in face-to-face and online classes categorized as “lecture,” “seminar,” or “laboratory” are directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student’s feedback via the SFS database is aggregated with that of other students enrolled in the course. Students’ anonymity will be protected to the extent that the law allows. UT Arlington’s effort to solicit, gather, tabulate, and publish student feedback is required by state law and aggregate results are posted online. Data from SFS is also used for faculty and program evaluations. For more information, visit http://www.uta.edu/sfs.
Final Review Week: for semester-long courses, a period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week unless specified in the class syllabus. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures: Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit, which is located [insert a description of the nearest exit/emergency exit]. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

Students should also be encouraged to subscribe to the MavAlert system that will send information in case of an emergency to their cell phones or email accounts. Anyone can subscribe at https://mavalert.uta.edu/ or https://mavalert.uta.edu/register.php

Student Support Services: UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at http://www.uta.edu/universitycollege/resources/index.php.

The IDEAS Center (2nd Floor of Central Library) offers free tutoring to all students with a focus on transfer students, sophomores, veterans and others undergoing a transition to UT Arlington. To schedule an appointment with a peer tutor or mentor email IDEAS@uta.edu or call (817) 272-6593.

The English Writing Center (411LIBR): The Writing Center Offers free tutoring in 20-, 40-, or 60-minute face-to-face and online sessions to all UTA students on any phase of their UTA coursework. Our hours are 9 am to 8 pm Mon.-Thurs., 9 am-3 pm Fri. and Noon-6 pm Sat. and Sun. Register and make appointments online at http://uta.mywconline.com. Classroom Visits, workshops, and specialized services for graduate students are also available. Please see www.uta.edu/owl for detailed information on all our programs and services.

The Library’s 2nd floor Academic Plaza offers students a central hub of support services, including IDEAS Center, University Advising Services, Transfer UTA and various college/school advising hours. Services are available during the library’s hours of operation. http://library.uta.edu/academic-plaza

Emergency Phone Numbers: In case of an on-campus emergency, call the UT Arlington Police Department at 817-272-3003 (non-campus phone), 2-3003 (campus phone). You may also dial 911.
From the UT Arlington Library.

Faculty members should feel free to incorporate any of the following information into your course syllabus or other course materials. All library services can be found by going to the main page. For direct links, see below.

Library Home Page library.uta.edu

Resources for Students
Academic Help
Academic Plaza Consultation Services library.uta.edu/academic-plaza
Ask Us ask.uta.edu/
Library Tutorials library.uta.edu/how-to
Subject and Course Research Guides libguides.uta.edu
Subject Librarians library.uta.edu/subject-librarians

Resources
A to Z List of Library Databases libguides.uta.edu/az.php
Course Reserves pulse.uta.edu/vwebv/enterCourseReserve.do
FabLab fablab.uta.edu/
Special Collections library.uta.edu/special-collections
Study Room Reservations openroom.uta.edu/

Teaching & Learning Services for Faculty
Copyright Consultation library-sc@listserv.uta.edu
Course Research Guide Development, Andy Herzog amherzog@uta.edu or your subject librarian
Data Visualization Instruction, Peace Ossom-Williamson peace@uta.edu
Digital Humanities Instruction, Rafia Mirza rafia@uta.edu
Graduate Student Research Skills Instruction, Andy Herzog amherzog@uta.edu or your subject librarian
Project or Problem-Based Instruction, Gretchen Trkay gtrkay@uta.edu
Undergraduate Research Skills Instruction, Gretchen Trkay gtrkay@uta.edu or your subject librarian.