

# ECE 8740 Advanced Nonlinear Control

## Section 1 (3 credit hrs)

Spring 2020

### General Information:

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Instructor: Dr. Yongqiang Wang ([yongqiw@clermson.edu](mailto:yongqiw@clermson.edu)),  
Fluor Daniel Building 332, (864) 656-5923

Office hours: TBD or by appointment

Lecture: 3:30 pm - 4:45pm (Mondays & Wednesdays) in Riggs 219 from Jan. 8 - May, 01, 2020

Course webpage: <https://www.clemson.edu/canvas/>

Text: Our main reference will be: Nonlinear Systems (3<sup>th</sup> edition) Hassan K. Khalil

### Course Description & Objectives:

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This course is developed as an introduction to nonlinear control. The purpose of the course is to introduce the nature of nonlinearities found in control systems both in the forward path and in the feedback path. Sometimes nonlinearities may be used to adjust the performance of the system. Students are expected to learn why standard methods of analysis and design in linear systems are not applicable in nonlinear systems. Methods suitable for nonlinear systems are introduced and their applications are explored. Prerequisite: ECE 801.

### Optional Reference Texts (From which you will find great insight):

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- 1) *Applied Nonlinear Control*, Jean-Jacques Slotine, Weiping Li, Pearson Education, 1990.
- 2) *Nonlinear Control Systems*, Horacio J. Marguez, Wiley, 2003.
- 3) *Nonlinear Systems: Analysis, Stability, and Control*, S. Sastry, Springer-Verlag, 1999.
- 4) *Nonlinear Control Systems*, A. Isidori, Springer-Verlag, 1989.

### Course Topics (Subject to change, may not cover all items below):

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- 1) General overview
- 2) Basic Lyapunov theory
- 3) Limit cycles
- 4) Invariant Sets
- 5) Time-varying systems
- 6) Adaptive control
- 7) Optimization
- 8) Game theory

### Grading:

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1. Homework: 3×10%
2. Mid-term: 10%
3. Final: 10%

4. Project: 50% (20% presentation + 20% report + 10% weekly progress reports)

### **Requirements on Project and Presentation:**

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Projects must be research projects contributing new theory and/or applications to the nonlinear systems community. The results should be a research publication suitable for a high-quality conference or workshop.

- 1) Project topic one: nonlinear dynamics in distributed optimization (reference will be provided)
- 2) Project topic two: nonlinear dynamics in game theory (reference will be provided)
- 3) Project topic three: student proposed topic with instructor's approval

For all projects, the requirements are:

- 1) A meeting with the instructor to discuss and approve your project proposal by Jan. 29, 2020 (preferably sooner);
- 2) Weekly progress reports are required to be sent to the instructor by the end of every week;
- 3) A project presentation (25 minutes) in class between April 15-22, 2020;
- 4) A project report in IEEE conference paper style. Due April 22, 2020 at 11:59 pm, via email (confirmations will be given if successfully submitted).

*With the approval of the instructor, if the report is submitted for publication in a high-quality journal, grade "A" will be given.*

### **Policies:**

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Students may leave after 10 minutes if the instructor or guest lecturer does not arrive in that time. Attendance while not required is highly recommended. Students who regularly attend class and participate will receive special consideration if course average is borderline. Students are responsible for getting lecture notes, and handouts for missed classes from fellow students or from the class website when applicable. Any exam that was scheduled at the time of a class cancellation due to inclement weather will be given at the next class meeting unless contacted by the instructor.

Any assignments due at the time of a class cancellation due to inclement weather will be due at the next class meeting unless contacted by the instructor. Any extension or postponement of assignments or exams must be granted by the instructor via email or Canvas within 24 hours of the weather related cancellation.

It is recommended that students check their email daily for important announcements, assignments, and other class related information. It is preferred that you use your clemson.edu account and not forward to another account (e.g. hotmail, yahoo, etc.) as there is the potential for lost information with these systems.

Scantron is available through the department but will not be used in the class.

### **Academic Integrity:**

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If someone else's work (code, slides, research publications, etc.) is used to produce any work you do for this course, you must (1) indicate how this work was used, and (2) acknowledge this work in a bibliography section. For presentations, you must create your own slides.

This course follows Clemson University procedures. Students suspected of violating academic integrity will be reported. The official statement of Clemson University on Academic Integrity:

*"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to*

*truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity.”*

More details of the graduate academic integrity policy are available at:

<http://gradspace.editme.com/AcademicGrievancePolicyandProcedures#intergritypolicy>

### **Disability Services:**

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Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to this class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848, by emailing [studentaccess@lists.clemson.edu](mailto:studentaccess@lists.clemson.edu), or by visiting Suite 239 in the Academic Success Center building. Appointments are strongly encouraged – drop-ins will be seen if possible, but there could be a significant wait due to scheduled appointments. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student’s responsibility to follow this process each semester. You can access further information here: <https://www.clemson.edu/academics/studentaccess/index.html>.

### **Title IX Statement:**

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The Clemson University Title IX (Sexual Harassment) statement: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran’s status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The policy is located at <http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html>. Alesia Smith is the Clemson University Title IX Coordinator, and the Executive Director of Equity Compliance. Her office is located at 110 Holtzendorff Hall, 864.656.3181 (voice) or 864.656.0899 (TDD).