ECE 8740 Advanced Nonlinear Control

Section 1 (3 credit hrs)

Spring 2024

General Information:

Instructor: Dr. Yongqiang Wang (yongqiw@clemson.edu), (805) 4532818

Meeting time: 8:00 am - 9:15 am Tuesdays and Thursdays at Riggs 223 (1/10/2024 - 5/03/2024)

Office hours: Online (https://clemson.zoom.us/j/9209214331) by appointment

Course webpage: http://www.clemson.edu/canvas

Text: Readings from the literature

Course Description & Objectives:

This course is developed as an introduction to nonlinear control. The purpose of the course is to introduce the application of nonlinear analysis in various domains including control, robotics, optimization, engineered systems, machine learning, and many others. Students are expected to learn to use nonlinear analysis/synthesis techniques to address practical problems in domains of their interests.

Optional Reference Texts (Recommended Reading for More Information):

1) *Applied Nonlinear Control, Jean-Jacques Slotine, Weiping Li, Pearson Education, 1990.*
2) *Distributed Control of Robotic Networks*, by F. Bullo and J. Cortés and S. Martínez, Series in Applied Mathematics, Princeton, 2009
3) *Distributed Consensus in Multi-vehicle Cooperative Control*, W. Ren and R. W. Beard, Communications and Control Engineering Series, Springer-Verlag, London, 2008
4) *Nonlinear Dynamics and Chaos: with Applications to Physics, Biology, Chemistry, and Engineering*, by S. Strogatz, Westview Press, 2001.
5) More materials (papers) to be announced

Course Topics (Subject to change):

1) General overview
2) Stability and convergence theory
3) Distributed systems
4) Iterative methods
5) Optimization
6) Machine learning

Grading:

1) Class Participation and Presentations: 50% (10%+20%+20%)
2) Paper-format Reports (6 pages): 50%

Schedule (Subject to change):

The course schedule is divided into three parts:

1. Seminars/lectures (recorded videos of seminars given by world-renowned researchers) (about 8 weeks)
2. Students will discuss selected papers (about 4 weeks)
3. Students research project discussions (about 2 weeks)

Requirements on Paper Presentation:

Students are required to present one research paper. Each student records his/her presentation and upload to Box. The paper should represent the state-of-art of corresponding research topics and have substantial theoretical depths. Through studying and presenting a paper, a student is expected to gain substantial knowledge about the forefront of a nonlinear related topic and be able to conduct research on the topic. Students are encouraged to select a paper that is relevant to his/her final project or thesis.

For paper presentations, the requirements are:

1) Select a paper (a list of recommended papers is available in Box) and email me your choice by Jan. 25, 2024 and (preferably sooner);
2) Thoroughly and completely understand the selected paper (including the contents in "appendix" and "supplemental materials");
3) Present the paper and record the presentation. Both the idea and technical details of the papers are required to be presented.
4) Present your paper to the class (starting Feb. 27, 2024);

Requirements on Project and Presentation:

A large part of the course grade is based on a research project. Students may work on projects alone or with a partner. Groups of three may also be allowed if approved by me. Projects must be research projects related to nonlinearity. You are encouraged to come up with a project that relates to your research.

The project topics can be:

1) Decentralized learning/optimization theory
2) Learning based robotic networks
3) Other projects that are proposed by students and approved by the instructor

For all projects, the requirements are:

1) A meeting with me to discuss and approve your project proposal by Feb. 22, 2024 (preferably sooner);
2) A short project status report (1–2 single-column pages) with 5 to 10 references due on March. 22, 2024;
3) A recorded project presentation should be uploaded to Box before April 26, 2024;
4) A project report in IEEE conference paper style. Due April 26, 2024, via email (confirmations will be given if successfully submitted).

Policies:

Students may leave after 10 minutes if the professor 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 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:

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:

Students with disabilities who need accommodations should make an appointment with me to discuss specific needs within the first month of classes. Students should present a Faculty Accommodation Letter from Student Disabilities Services when we meet. Student Disability Services is located in G-20 Redfern (phone number: 656-6848, email: sds-l@clemson.edu). Please be aware that accommodations are not retroactive and new FAL must be presented each semester.

Title IX Statement:

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. Jerry Knighton serves as Clemson's Title IX coordinator and he may be reached at knightl@clemson.edu or 656-3181.

Modification Statement:

The instructor reserves the right to modify any aspect of the syllabus at any time during the semester for reasons including but not limited to COVID related situations.

Copyright Statement: