14:650:504 Advanced Control I

Part 1: Course Information

Instructor Information

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Course Description

Abstract: This course covers the key topics of advanced modern control design, which includes state-space representation, stability, controllability and state feedback, observability, and state estimation, optimal LQR / LQG regulators. These techniques are applied to aerospace and/or robotic examples through a project. Extensive use of MATLAB/Simulink will be required.

Possible Outline:

I) System Representation

- State Space Representation,
- Linearization,
- Impulse response and transfer function,
- Solutions to LTI systems,
- Jordan Normal form

II) Stability of LTI systems, Lyapunov stability

III) Controllability, Stabilizability, pole placement

IV) Observability, detectability, Kalman decomposition

V) Optimal LQR, LQG regulators

VI) Advanced topics (Q design, balanced model reduction, model predictive control, data based LQR control..) (depending on the time left)

Prerequisite

- the following Rutgers courses (or equivalent): (14:650:401 System Dynamics and Control) and (01:640:421 Adv. Calc. for Engineering).

Textbook & Course Materials

Recommended Textbook

- "*Linear Systems Theory",* by João P. Hespanha, Princeton Press, 2nd edition, 2018.

Other Readings

- "*Feedback Systems: an introduction for scientists and engineers*", k.J. Åström and R.M. Murray, Princeton Press, 1st edition, 2008.
- "*Data-driven Science and Engineering*", Cambridge University Press, by Steven Brunton and Nathan Kutz, 2019.
- "*Systems and Control Theory: lecture notes*", by Franco Blanchini
  http://users.dimi.uniud.it/~franco.blanchini/Lecture_notes_12.pdf

Course Requirements

- A simple 4-function electronic calculator (no other electronic device is permitted to be used during any exam).
- All exams are closed book, closed notes, with one self-prepared formula sheet allowed

Part 2: Learning Outcomes and Grading Policy

Course Learning Outcomes/Assessment Tools:

Course Learning Outcomes	Assessment Tools
1. Provide a conceptual framework for quantitative analysis of linear controlled systems	HW, Exams, Group project
2. Introduce technical, professional, and ethical challenges of engineering endeavors through success and failure case studies	Class discussion
3. Develop an environment for active learning leading to mastering the concepts of stability analysis and feedback control synthesis for linear systems.	HW, Exams, Group project

Graded Course Activities

Homework is regularly assigned but neither collected or graded.

The only admissible materials during **EXAMS** are 1) one single sheet (= 2pages) with personal notes, and 2) a simple 4-function electronic calculator.

Points	Description
35	Written exam 1
35	Written exam 2
30	Final project
100	Total Points Possible

Any questions regarding the **written exams and project scores** must be discussed with the instructor within two weeks of the date of return of these scores to the class and no changes in these scores will be considered after these two weeks.

Inform Your Instructor of any Accommodations needed within the first two weeks of the course.

Commit to Integrity

As a student in this course (and at this university) you are expected to maintain high degrees of professionalism, commitment to active learning and participation in this class and also integrity in your behavior in and out of the classroom.