ECE 6320 Syllabus

Instructor

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Class Time: 10:30 am -11:45 am (Tu, Thu)

Class Room: EL 109

Office hours: TBD

Assessment format

Homework – 40%

Mid-term exam – 30% (November 12th: In Class)

Class project – 30%

Textbook

The course will follow closely:

[1] C.-T. Chen. Linear Systems Theory and Design. Oxford Univ. Press, 4th ed., 1999. (ISBN 0-19-511777-8)

Other recommended textbooks are:
[2] P. Antsaklis, A. Michel. Linear Systems. McGraw Hill, 1997.
[3] J. Hespanha. Linear Systems Theory, 2009. (ISBN-13: 978-0-691-14021-6). Details available here.

All students are strongly encouraged to review linear algebra. Chapter 3 of [1] provides a brief summary but a review of a Linear Algebra textbook (such as [4] below) is preferable, especially if one goes through a few exercises.
[4] Gilbert Strang Linear Algebra and Its Applications, 1988.

[5] Awesome Video Lecture by Prof Strang (http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/)

[6] Introduction to Linear Dynamic Systems: Video Lectures by Prof Stephen Boyd, Stanford

http://see.stanford.edu/see/lecturelist.aspx?coll=17005383-19c6-49ed-9497-2ba8bfcfe5f6

Homework

- On line submission on canvas (nice and clear scans or typed)
- Solutions will be posted two days after due date.
- Late home work not accepted
- Discussion is allowed but do not copy.

Midterm Exam

1. In class closed book, closed notes, closed friends, and closed internet.

2. Oct 14th Tuesday

Project

See some of the last year simulation videos and project at:https://multivariablecontrol.wordpress.com/projects/

1. Two student team
2. Abstract due Oct 10th
3. Target for a conference
4. Report (two column ieee style paper format)
5. Presentation
6. Weekly Update on a shared google doc after Oct 15th.

Course Goals:

1. Model linear dynamic systems using state space methods.
2. Analyse stability, controllability, and observability of linear systems.
3. Design controllers and observers for linear systems using pole placement methods.

Related Material

1. Making presentation in Tex using Beamer (Tex Beamer.zip)
2. Writing Papers IEEE conf template (ieeeconf.zip, IEEEtran_HOWTO.pdf)
3. Animation and Modelling in SIMULINK (Animation and Modelling in Simulink.pdf, animation_fixed.zip) Inverted Pendulum Simulink Files (Inverted Pendulum.zip)

Lecture Notes

1. Lecture 1: Introduction and course overview (Lecture1.pdf) 09/01
2. Lecture 2: State Space and Lagrange's equations (Lecture2.pdf) 09/03
3. Lecture 3: Animation and Modelling in SIMULINK (Animation and Modelling in Simulink.pdf, animation_fixed.zip) Inverted Pendulum Simulink Files (Inverted Pendulum.zip) 09/07
4. Lecture 4: Linearization (Lecture3.pdf, Lecutre 3 (2014)_Linearization.pdf) 09/09
5. Lecture 5: Linear time invariant systems, impulse response, convolution, transfer function (Lecture5.pdf) 09/15
6. State space to transfer function, realization, proper transfer function (Lecture6.pdf)
7. State-space Solutions to LTI Systems (Read Ch-4 Chen) (09/17)(Lecture7.pdf)
8. State-space Solutions LTI using Jordan's Form (Read Ch-3 Chen and Lecture 7 Hespanha) (09/19)(Lecture8.pdf)
9. State-space Solutions to LTV Systems (Read Ch-4 Chen)(09/24)(Lecture9.pdf)
10. Lyapunov Stability (Lecture10.pdf)
11. Lyapunov Stability(Lecture11.pdf, Lecture_Stability.pdf)
12. Input Output Stability (Ch-5 Chen and Lecture 9 Hes)(Lecture12.pdf, Stability_Hespanha.pdf)
13. Preview of Optimal Control (Hespanha Lecture 10) 09/30 (Lecture13.pdf,Differential Flatness Based Control of a Rotorcraft For Aggressive Manuvers.pdf, Preview of Optimal Control_Hesphana.pdf, Lecture_Optimal_Control.pdf)

14. Differential Flatnes-based optimal control of a quad-rotor (Differential Flatness-based Quadrotor Control2.pdf) 10/07/2014
15. Review Session 10/09
16. Midterm Exam (Up to Ch-5 Stability in Chen): October 14th.
17. Controllability I (Lecture14_ControllabilityI.pdf, Matlab File of Example (Example1.m), Stability of Linearized Sys(StabofLinearized.m)) (Chen Ch-6)
18. Controllability and Kalman Decomposition (Lecture15_ControllabilityII.pdf) Matlab Files (aircraft_lateral.m, ExampleKalmanDecomp.m) (Chen -6)
19. Observability (Read Ch 6 Chen)(Lecture16_Observability.pdf)
20. Controllability and Observability of LTV systems (Lecture17_ControllabilityandObsLTV.pdf)
21. State feedback 1 (Lecture18_StateFeedback1.pdf)
22. State feedback 2 (Lecture19_StateFeedback2.pdf)
23. State feedback 3 and Linear observers 1 (Lecture20_LinearEstimators1.pdf, Inverted Pendulum_withObs.zip)
24. Reduced Order Observer and MIMO Feedback (Lecture21_Reduced Order Observer and MIMO Feedback.pdf)
25. Finding PID Gains (notes_pid.pdf)
26. Kalman and Extended Kalman Filter (The Extended Kalman Filter (EKF).pdf, GaussianFilters.pdf).

Help Session

1. Help Session Assignment 2: https://youtu.be/AenbkJDXSWs
2.

Video Lectures

1. Lecture 1: Course Overview 09/01/2015 (Sound after 6 min mark)http://youtu.be/F51BfoXv2OY
2. Lecture 2: State-Space and Lagrange's Equation http://youtu.be/huPsHVvlNU0
3. Lecture 3: Modeling and animation in Matlab http://youtu.be/vuXmnkK4pQQ
4. Lecture 4: Linearization https://youtu.be/pyMJd1eUU_s
5. Lecture 5: Feedback Linearization, Causal and LTI Systems

https://youtu.be/npAdd1zmsQE

6. Lecture 6: Convolution and Transfer Function https://youtu.be/p-7M2UZGgAs

Lecture 7: https://youtu.be/Jgpk6qS3ulY (Sound in this went out after 18 min..may be microphone battery went down)
Lecture 8: https://youtu.be/BjlNOWIS6dw Lecture 9: https://youtu.be/TfMpQkeGJbU