Syllabus
ECE 593E – Advance Topics ECE-Control Systems, Fall 2015

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Office Hours: Monday and Wednesday – 1:00 p.m. to 4:00 p.m. or by appointment

Course Description:
This is a first graduate level course on control systems which serves as a basis for future courses in optimal control (ECE 564), nonlinear systems analysis (ECE 565), adaptive control (ECE 566), and distributed and network control. In addition, the material covered in this course is applicable to the areas of signal processing, image processing, circuit theory, and detection and estimation theory.

The course is intended to provide a rigorous introduction to the structure and analysis of linear dynamical systems in time domain. Topics covered include linear algebra review, solutions of linear differential equations, state space representations, state transition matrix, and time varying systems. The course introduces the fundamental mathematics of linear spaces and linear operator theory, and considers the structural properties of linear systems such as controllability, observability, stability, realizations, and minimality. Design and synthesis of controllers and state observers for linear systems are discussed. More advanced topics presented in the course include linear quadratic regulator theory and an introduction to robust control.

Lecture: MWF, 12:00 p.m. – 12:50 p.m., Engineering, A Wing 0207

Recommended Textbook and References:

Instructional Objectives:
• To understand the concept of linear dynamical systems and to master mathematical tools for their analysis
• To master the methods of controller design in the time domain
• To provide a solid background for all following graduate courses in control

Course Topics: (subject to change at the instructor’s discretion)
State space representation (5 lectures)
Linear spaces, basis, norms, and inner products (3 lectures)
Change of bases, eigenvalues, and eigenvectors (3 lectures)
Diagonalization, Jordan forms, symmetric matrices (3 lectures)
Functions of square matrix, matrix exponential, and Cayley Hamilton theorem (3 lectures)
State space solutions: Time invariant and time Varying cases (3 lectures)
Properties of the state transition matrix (3 lectures)
Discretization of continuous systems, discrete-time state space models (3 lectures)
Analysis of discrete-time linear systems (3 lectures)
Internal Stability (2 lecture)
Uniform exponential stability and asymptotic stability (2 lectures)
Lyapunov stability theorems (2 lectures)
Controllability and observability (3 lectures)
Kalman decomposition, minimal realizations, and canonical forms (1 lecture)
State feedback: Pole placement (2 lectures)
Estimator design (2 lecture)
State observers (1 lecture)
Reduced order observers/BIBO stability (2 lecture)
Linear optimal control (3 lectures)
Linear Quadratic Regulator (2 lecture)

Grading/Evaluation:
Homework 20%
Midterm Exam 35%
Final Exam 45%

Classroom Policies:
A. Late homework is not accepted. If an exam is missed for a legitimate reason, a grade will be assigned based on the remaining homework/exams.
B. Students are encouraged to discuss problems in groups, but all written submitted work should be individual in nature.
C. Usage of electronic devices (music equipment, cell phones, text messaging devices and computers) is disallowed during regular class hours.

University Policies
A. Incomplete Grades: An INC is assigned when, for reasons beyond their control, students engaged in passing work are unable to complete all class assignments. An INC must be changed to a completed grade within a time period designated by the instructor but not to exceed one year from the close of the term in which the course was taken, or graduation, whichever occurs first. Should the student fail to complete the course within the time period designated, not to exceed one year, or graduation, whichever comes first, the incomplete will be converted to a grade of F and the grade will be computed in the student’s grade point average. Students should not reregister for courses in which an INC has been assigned with the intent of changing the INC grade. Re-registration will not prevent the INC from being changed to an F.
B. Academic Integrity: You are expected to submit your original work and adhere to the academic policies as stated in the SIU Student Conduct Code: http://srr.siu.edu (listed under Additional Links). Any act of academic dishonesty, cheating, or plagiarism in any form, including anonymous internet sources used in student papers, will be reported. These acts are taken seriously and the consequences may range from failing as assignment to
expulsion from the university.

C. **SIU Email:** Your SIU email account is an official form of University communication. Your instructor will use SIU email as a primary means of electronic communication with students. Please make sure that you maintain a valid password and acquire the habit of regularly checking your SIU email account for important instructor and University announcements. You may view the official SIU Student Email Policy at: [http://policies.siu.edu/policies/email.html](http://policies.siu.edu/policies/email.html).

D. **Emergency Procedures:** SIU is committed to providing a safe and healthy environment for study and work. Because some health and safety circumstances are beyond our control, we ask that you become familiar with SIU Emergency response Plan and building Emergency Response Team (BERT) program. Emergency response information is available on posters in buildings on campus, available on BERT’s website at [http://www.bert.siu.edu/](http://www.bert.siu.edu/), the SIU Department of Public Safety’s website [www.dps.siu.edu](http://www.dps.siu.edu) (disaster dropdown and video, “Shots Fired”), and in the Emergency Response Guideline pamphlet. Know how to respond to each type of emergency. Instructors will provide guidance and direction to students in the classroom in the event of an emergency affecting your location. **It is important that you follow these instructions and stay with your instructor during an evacuation or sheltering emergency.** The Building Emergency Response Team will provide assistance to your instructor in evacuating the building or sheltering within the facility.

E. **Supplementary Assistance:** SIU is committed to assisting students with disabilities. With the cooperation of SIU’s Disability Support Services (DSS), each student who qualifies for reasonable supplementary assistance has the right to receive it. Students requesting supplementary assistance must first register with DSS in Woody Hall, B-150, 618-453-5738 or 618-453-2293 (TTY), by email [DSS@siu.edu](mailto:DSS@siu.edu), or [http://disabilityservices.siu.edu/](http://disabilityservices.siu.edu/). Notice: If you have any type of special need(s) or disability for which you require accommodations to promote your learning in class, please contact me as soon as possible. The Office of Disability Support Services (DSS) offers various support services and can help you with special accommodations. You may wish to contact DSS to verify your eligibility and options for accommodations related to your special need(s) or disability.

**Student Services**

A. **Learning Support Services:** The Center for Learning Support Services (CLSS) assists students of all cultures, abilities, backgrounds and identities with enhancing their self-management and interdependent learning skills. Programs offered by CLSS include: group study sessions; math tutoring; academic coaching; early intervention program; and study skills seminars. For additional information please contact CLSS in Woody
B. Writing Center: The Writing Center offers free tutoring services and assistance with improving writing skills to all SIU undergraduate students and faculty. For center locations and hours, to schedule an appointment online, and to view information regarding the Online Writing Lab (OWL) contact the Writing Center at 618-453-1231 (Morris Library location); 618-453-2927 (Trueblood location), or www.write.siu.edu.

C. Saluki Cares: The purpose of Saluki Cares is to develop, facilitate and coordinate a university-wide program of care and support for students in any type of distress-physical, emotional, financial or personal. By working closely with faculty, staff, students and their families, SIU will continue to display a culture of care and demonstrate to our students and their families that they are an important part of the community. To make a referral to Saluki Cares click, call or send: http://salukicares.siu.edu/index.html; 618-453-5714, or siucares@siu.edu.