EPD 30.114 – Advanced Feedback & Control

Spring 2017

Days of Week (MT) – Section A: - Room: ARMS One/Two/Three

	Prof Foong Shaohui
Office:	3.301.05
Phone:	63036670
E-mail:	shao@sutd.edu.sg
Office Hours:	WF: 1-3pm or by appointment

Goal: The goal of this class is to build on understanding of linear time-invariant state space systems to synthesize and evaluate advanced feedback controllers as well as digital implementation of such controllers.

Text: *Feedback Control of Dynamic Systems by Gene F. Franklin, J. David Powell, Abbas Emami-Naeini (Sixth Edition)*

Modern Control Engineering by Katsuhiko Ogata (Fifth Edition)

Discrete-time Control Systems, Author: Katsuhiko Ogata (Second Edition)

In order to gain greater benefit from the lectures, you should complete the assigned reading before coming to class. Even a superficial first reading the night before the class period will improve your comprehension and retention of the material covered in class. Your performance in this course will rely on how well you assimilate the assigned reading. You also will be tested on assigned reading material that may not be covered during meeting times.

References:

Digital Control of Dynamic Systems by Gene F. Franklin, J. David Powell, Michael Workman (Third Edition)

Linear Systems Theory by João P. Hespanha.

Linear Systems by Thomas Kailath.

Prerequisites: 30.101 Systems & Control. *Prerequisites will be strictly enforced.*

Course Description: Extending feedback control theory and applications to include periodic signals and discrete-time systems. Mathematical modeling and analysis of discrete time systems in various disciplines using state-space, pulse transfer function and z-transform. Relating controllability and observability and their canonical forms to synthesize and design advanced continuous and discrete-time controllers. Introduction of pole-placement based controller design and formulation of state observers.

Learning Objectives:

- Represent physical systems in continuous state-space canonical forms and solve the linear time-invariant (LTI) state equation.
- Assess the controllability and observability of LTI state-space continuous-time and discrete-time systems for stability analysis, design of controllers and regulators with specific dynamic performances.
- Extend modelling principles to describe discrete-time systems and represent them using pulse transfer functions and state-space.
- Analyze and synthesize discrete time control systems using the *z* transform and root locus.
- Convert a continuous time system to a discrete-time system and vice-versa.

Measurable Outcomes:

- Given a physical system, conceive a set differential equations and difference equations describing continuous and discrete-time model of the system and representing it state-space. [LO1, LO3]
- Describe the notion of controllability and observability for both continuous and discrete-time systems and design full and reduced-order state observers and state feedback and integral controllers [LO2].
- Apply Eigenvalue analysis to determine poles and subsequent stability of state-space system. [LO2]
- Based on a performance specification, design a suitable digital compensator for a discrete-time system using z-transform and on the z-plane using root-locus analysis. [LO2]
- Model and represent discrete time signals and systems using the z Transform and solve LTI difference equation and the systems that these equations describe using the inverse z transform and the z plane. [LO4]
- With a system described in a continuous-time representation, express the corresponding system in a discrete-time representation and be able to map between the s-plane of continuous systems to z-plane of discrete-time systems. [LO5]

Pedagogy: Integrated and unified theoretical and practical approach in continuous-time and discrete-time control engineering and their applications.

Attendance: Full attendance is required. Re-occurring unjustified absences will result in a least a letter grade reduction.

Grading: Final exam (30%), Mid-term (25%), 1-D, 3-D Projects (20%), In-Class Assignments & Homework (15%), Instructors prerogative (10%)

Projects: The 1D/2D projects will connect theoretical and practical implementation of controllers as well as applying modelling principles and methods for Capstone projects.

Assignments: All assignments must be turned in on time. Assignments will not be accepted/graded after the due date/time. Do not attempt to hand-in late assignments, unless you have *prior* approval of the faculty.

Exam(s): Mid-term on 1 Mar 2017 (Wednesday). Finals on 28 April 2017 (Friday).

Final Exam: There will be a final exam. No exceptions.

SUTD Assistance: SUTD provides upon request appropriate academic adjustments for qualified students with disabilities. Please contact the Office of Student Life and the faculty to discuss and plan for the term.