EPD 30.101 – Systems & Control

Spring 2016

Room: ARMS One/Two/Three

	Prof Foong Shaohui	Prof Suranga Nanayakkara	Prof David Braun
Office:	3.301-05	3.301-04	1.302-12
Phone:	63036670	63036668	64994860
E-mail:	shao@sutd.edu.sg	suranga@sutd.edu.sg	david_braun@sutd.edu.sg
Office Hours:	WF: 1-3pm	MW: 3-5pm	MW: 10-12

Goal: The goal of this class is to introduce the fundamental basics of signal processing and control concepts in physical systems. Focused on continuous linear time invariant (LTI) systems.

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

Modern Control Engineering by Katsuhiko Ogata

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:

Signals and Systems by Alan V. Oppenheim, Alan S. Willsky with S. Hamid

Automatic Control Systems by Benjamin C. Kuo, Farid Golnaraghi

Prerequisites: *Prerequisites will be strictly enforced.* 30.001 Circuits & Electronics, 10.007 Modelling the Systems World.

Course Description: Lumped parameter mathematical modelling and analysis of continuous time systems and signals in various disciplines using state-space and transfer function approaches and the Laplace transform. Analysis of linear time-invariant (LTI) systems and signals in time and frequency domains for synthesis and design of automatic feedback controllers.

Learning Objectives:

- Demonstrate understanding of various mathematical models, via lumped parameter analysis, by deriving transfer functions and state-space models of physical (translational and rotational mechanical, electrical, electromechanical, fluid and thermal) systems.
- Appreciate analogous systems where a model describing one physical system can be directly applied to analogous system in another field.
- Utilize Laplace and inverse Laplace transforms to analyze, characterize and solve the differential equations representing continuous LTI systems.

- Analyze and simulate transient, steady-state and frequency response of first and second-order LTI systems.
- Demonstrate an understanding of convolution, Fourier Series, Fourier Transform and their properties.
- Understand concept of the characteristic equation, stability and implications for physical systems.
- Create block-diagram representations of linear systems using summing and branch points as well as feedback and cascading elements.

Measurable Outcomes:

- With an arbitrary physical system, generate a representative mathematical model (transfer function and state space model) of the system and describe features (system order, poles, zeros) and characteristics of the system (stability, transient and steady-state response).
- Take advantage of mechanical-electrical analogies to derive the differential equations of mechanical systems using electrical RLC (resistor-inductor-capacitor) networks and vice versa using mass-spring-damper systems.
- Solve initial value problems using characteristic values and characteristic vectors
- Based on a performance specification (stability, settling time, disturbance rejection, steady state error, etc), conceptually design a suitable PID feedback controller.
- Use the Routh's stability criterion to assess the conditions necessary for stability in LTI systems
- Calculate LTI system response for various continuous inputs including impulse and step.

Pedagogy: Integrated and unified theoretical and practical approach in signal processing and 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 (35%), Mid-term (25%), 1-D, 2-D Projects (15%), In-Class Assignments & Homework (15%), Instructors prerogative (10%)

Projects: 1D and 2D projects are collaborative assignments. While groups may discuss over the approach and methodology, each group must submit a unique and independent report. Reports from multiple groups that appear too similar may be penalized.

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 4 Mar 2016 (Friday). Finals on 29 April 2016 (Friday). You will be allowed a 2 page formulae sheet for the mid-term and a 4 page formulae sheet for the finals.

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.