Control Systems 414 **Feb 2016**

Overview of Control Systems

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An overview of control systems up to now:

In 3rd year you did…

1) Modelling of Continuous Dynamic Systems
   - Results in differential equations (DE)
   - Laplace transform of DE gives you the transfer function (TF)

2) Why Feedback Control
   - Disturbance rejection
   - Change dynamic response of system
   - Insensitivity of response to parameter variations

3) Classical Control (Continuous)
   - Use of Laplace Transform
   - Theory developed provides insight and eases hand calculations
   - Controller types
   - PID controller and variations (function of each element)
   - Lead and lag networks
   - Design tools
   - Frequency domain design using Bode plots
   - s-plane design using root locus

4) State Space Control (Continuous)
   - Work in the time domain
   - Theory provides less insight but better for computer aided design (CAD)
   - Controller Types
   - Full state feedback
   - Estimator provides full state estimate using limited measurements
   - Issues such as controllability and observability
   - Various ways of introducing reference input
   - State augmentation for implementing integral control
   - Design tools
   - Control and Observer canonical forms ease hand calculations
   - MATLAB provides many functions such as acker.m and place.m

5) Classical Control (Discrete)
   - Same as classical continuous control but now the controller is discrete
   - Looked at design by emulation to allow continuous control methods to be used
   - Looked at direct digital design on the z-plane root locus
   - Used the Z-transform
   -

THIS IS WHERE YOU ARE NOW!

In 4th year you are going to do…

6) More Discrete Control
   - Most of this work will similar to the continuous control methods of the third year, now applied
   - to discrete/hybrid systems
   - The idea is to give the work a practical flavour to round off your control systems knowledge
   - Controller is now discrete but plant is mostly still continuous
   - Direct design in discrete time domain (State Space) (12 lectures)

  - Discrete equivalent state space models (as we did with G(s) -> G(z))
  - State feedback control law design
  - Estimator design (predictor and current)
  - Combining the controller and estimator
  - Introduction of the reference input
  - Integral control in discrete time systems
- New topics that we are going to look at for discrete systems
  - Optimal control – Linear Quadratic Regulator (LQR) (5 lectures)
  - Optimal estimation – Kalman filter and least squares (4 lectures)

7) Nonlinear Control (Continuous)
   - Describing functions and applications
   - Phase plane analysis and applications
   - Lyapunov stability theory and applications

Semester Roadmap:

See the study guide

What you need to know in Gopal:

When studying for the tests, use the notes I have given you in conjunction with the book (I reference the book from the notes). The notes I have given you should however be sufficient. A summary of the important parts of the book (for second part of the course) is given below.

Chapters 2, 3, 4.2, 4.4

These chapters largely contain theory that you should already be familiar with from Control Systems 344. There are also a number of practical control examples in chapter 3. You are welcome to read through these chapters but it is not necessary for this course.

Chapter 5

This chapter largely contain state variable theory for continuous time systems that you should already be familiar with from Control Systems 344. You are welcome to read through this chapter, but it is not necessary for this course.

Chapter 6

This chapter contains the theory for discrete state space systems

Section 6.1	Introduction
Section 6.2	State space models for SISO systems
Section 6.3	State space description for sampled continuous-time plants
Section 6.4	Leave out
Section 6.5	Leave out
Section 6.6	Controllability and observability tests
Section 6.7	Leave out
	Review examples 6.1 and 6.4

Chapter 7

This chapter handles state space design, but first develops everything for continuous time systems in Sections 7.1 to 7.8. This can be revised for background knowledge. Then Section 7.9 adapts all the results for discrete time systems, this part plus the class notes are important to study.

Section 7.9	State feedback control, Prediction and Current state observers, Separation principle, servo design and feedback with integral control.
Section 7.10	Leave out
	Review example 7.2

Chapter 8

This chapter handles optimal control through Lyapunov synthesis. However, I suggest that you use only the notes for this part of the course. You are welcome to read through the chapter for further background information.