

# Control Tutorials for MATLAB and Simulink

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## Author Information

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## Course Details

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### Description

Control Tutorials for MATLAB and Simulink is a set of modules consisting of control tutorials for MATLAB and Simulink, curriculum for a first course in systems dynamics and control and a set of homework problems and exams for a second course in controls.

- Control Tutorials for MATLAB and Simulink - Designed to help you learn how to use MATLAB and Simulink for the analysis and design of automatic control systems. They cover the basics of MATLAB and Simulink and introduce the most common classical and modern control design techniques.
- System Dynamics and Control - Modeling of electrical, mechanical and electromechanical systems. Analytic solution of open loop and feedback type systems. Root Locus methods in design of systems and evaluation of system performance. Time and frequency domain design of control systems.
- Controls II - Advanced study of root locus analysis. Frequency response analysis. Design and compensation techniques. Control system analysis and design using state-space methods.

### Prerequisites:

- Module 1
  - MATLAB Basics

- Simulink Basics
- Module 2
  - Differential Equations
- Module 3
  - Laplace transforms, differential equations, transfer functions, root locus and Bode plot construction, MATLAB and Simulink

## Original Course Documents

Source file URL [Control Tutorials for MATLAB and Simulink](#)

# Course Contents

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## MODULE 1: Control Tutorials for MATLAB and Simulink

### System

#### Modeling

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

#### Analysis

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

## Control

### PID

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

### Root Locus

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

### Frequency

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

### State-Space

- Introduction
- Cruise Control

- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

## Digital

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

## Simulink

### Modeling

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch
- Ball & Beam

### Control

- Introduction
- Cruise Control
- Motor Speed
- Motor Position
- Suspension
- Inverted Pendulum
- Aircraft Pitch

- Ball & Beam

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## MODULE 2: System Dynamics and Control

### Lesson 1

- Lecture 1 - Introduction to modeling, control, differential equations
- Lecture 2 -Laplace transform definition and properties

#### Reading

- Chapter 1 and Section 2.1 of the book
- Sections 2.2 and 2.3 of the book

#### Problem Set

- Problem Set 1

### Lesson 2

- Lecture 3 - Solving differential equations with Laplace
- Lecture 4 - Mechanical system models

#### Reading

- Sections 2.4 and 2.5 of the book
- Sections 3.1 to 3.3 of the book

#### Problem Set

- Problem Set 2

### Lesson 3

- Lecture 5 -Transfer functions and block diagrams
- Lecture 6 - Time response

#### Reading

- Sections 4.1 and 4.2 of the book
- Sections 4.3 and 4.4 of the book

### Problem Set

- Problem Set 3

## Lesson 4

- Lecture 7 - State-space models
- Lecture 8 - Electrical system models

### Reading

- Sections 5.1 to 5.3 and 5.5 in the book
- Sections 6.1 to 6.3 in the book

### Problem Set

- Problem Set 4

## Lesson 5

- Lecture 9 - Electromechanical systems
- Lecture 10 - DC Motors

### Reading

- Section 6.5 in the book

### Problem Set

- Problem Set 5

## Lesson 6

- Lecture 11 - Linearization (Taylor Series expansion)
- Lecture 12 - First-order system response, stability

### Reading

- Section 7.4 in the book

Sections 8.1 and 8.2 in the book

### Problem Set

- Problem Set 6

## Lesson 7

- Lecture 13 - Second-order system response
- Lecture 14 - Higher-order system response, system identification

### Reading

- Section 8.3 in the book
- Section 8.4 in the book

### Problem Set

- Problem Set 7

## Lesson 8

- Lecture 15 - Introduction to control, block diagram manipulation
- Lecture 16 - Control goals and specifications, PID control

### Reading

- Sections 10.1 and 10.2 in the book
- Sections 10.3 to 10.5 in the book

### Problem Set

- Problem Set 8

## Lesson 9

- Lecture 17 - System type and steady-state error
- Lecture 18 - Root locus basics

### Reading

- Section 10.6 in the book

Sections 10.8 and 10.9 in the book

### Problem Set

- Problem Set 9

## Lesson 10

- Lecture 19 - Root locus continued
- Lecture 20 - Root Locus for Design

### Reading

- Sections 10.8 and 10.9 in the book

### Problem Set

- Problem Set 10

## Lesson 11

- Lecture 21 - Frequency response and Bode plots
- Lecture 22 - Analysis with Bode plots

### Reading

- Sections 9.1, 9.2, 11.1 and 11.2 in the book
- Sections 11.2 to 11.4 in the book

### Problem Set

- Problem Set 11

## Lesson 12

- Lecture 23 - Bode plots for controller design
- Lecture 24 - More advanced control architectures

### Reading

- Section 11.6 in the book

## Problem Set

- Problem Set 12

## Lesson 13

- Lecture 25 - Controller implementation and advanced topics

### Reading

- Review

### Problem Set

- Problem Set 13

## Project

Lab 1

Lab 2

## Quizzes

Quiz 1

Quiz 2

Quiz 3

Quiz 4

Quiz 5

Quiz 6

Quiz 7

## Exams

Mid-term Exam

Final Exam

## Textbooks

Ogata, K., *System Dynamics*. 4th Ed., Pearson Prentice Hall, 2004.\*

Franklin, G., Powell, J.D., and Emami-Naeini, A., *Feedback Control of Dynamic Systems*. <sup>F</sup>

Nise, Norman S., *Control Systems Engineering*. <sup>†</sup>

<sup>\*</sup> *Required Material*

<sup>†</sup> *Supplemental Material*

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## MODULE 3: Controls II

### Problem sets

- Problem Set 1
- Problem Set 2
- Problem Set 3
- Problem Set 4
- Problem Set 5
- Problem Set 6
- Problem Set 7
- Problem Set 8

### Exams

Mid-term Exam 1

Mid-term Exam 2

Final Exam

### Textbooks

Ogata, K., *Modern Control Engineering*. 5th Ed., Prentice Hall, 2010. <sup>\*</sup>

Franklin, G., Powell, J.D., and Emami-Naeini, A., *Feedback Control of Dynamic Systems*. <sup>†</sup>

Nise, Norman S., *Control Systems Engineering*. <sup>†</sup>

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## Links

YouTube Lecture Videos for a course similar to System Dynamics and Control.

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