ME451: Control Systems

Lecture 0
Introduction

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Instructor

- **Class Instructor**: Dr. Jongeun Choi,
  - Website: [http://www.egr.msu.edu/~jchoi/](http://www.egr.msu.edu/~jchoi/)
  - Assistant Professor at ME department,
  - 2459 Engineering Building,
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- **Office Hours**
  - 2459 EB, MW 2:00-3:00pm, Extra hours by appointment

- **Laboratory Instructor**: Dr. C. J. Radcliffe,
  - 2445 Engineering Building
  - Email: radcliff@egr.msu.edu

Course information

- **Lecture**:
  - When: MWF: 11:30am-12:20pm,
  - Where: C103 McDonel Hall

- **Class website**: [http://www.egr.msu.edu/classes/me451/jchoi/2008/](http://www.egr.msu.edu/classes/me451/jchoi/2008/)

- **Laboratory website**: [http://www.egr.msu.edu/classes/me451/radcliff/lab](http://www.egr.msu.edu/classes/me451/radcliff/lab)

- **Required Text**:

Main components of the course

- **Lectures** (about 40 lectures)
- **Midterm 1** (October 3rd, Friday, in class)
- **Midterm 2**
- **Final** (Final exam period)
- **Laboratory work**
- **Grading**:
  - Homework (15%), Exam 1 (15%), Exam 2 (15%), Final Exam (comprehensive) (30%), Laboratory work (25%)
  - Homework will be due in one week from the day it is assigned
Tips to pass this course

- Come to the lectures as many times as you can.
- Print out and bring lecture slides to the lecture.
- Do “Exercises” given at the end of each lecture.
- Do homework every week.
- Read the textbook and the slides.
- Make use of instructor’s office hours.
- If you want to get a very good grade...
  - Read the textbook thoroughly.
  - Read optional references too.
  - Do more than given “Exercises”.
  - Use and be familiar with Matlab.

Prerequisites: Complex Numbers

- Ordered pair of two real numbers
  \[ s := x + jy \in \mathbb{C}, \text{where } x, y \in \mathbb{R}, j = \sqrt{-1} \]
- Conjugate \[ \bar{s} = s^* := x - jy \]
- Addition \[ s_1 = x_1 + jy_1, s_2 = x_2 + jy_2 \]
  \[ s_1 + s_2 = (x_1 + x_2) + j(y_1 + y_2) \]
- Multiplication
  \[ s_1 s_2 = (x_1 + jy_1)(x_2 + jy_2) \]
  \[ = (x_1 x_2 - y_1 y_2) + j(y_1 x_2 + x_1 y_2) \]
  \[ s_s^* = |s|^2 = x^2 + y^2 \]

Complex Numbers

- Euler’s identity
  \[ e^{j \theta} := \cos \theta + j \sin \theta \]
  \[ \cos \theta = \frac{e^{j \theta} + e^{-j \theta}}{2}, \sin \theta = \frac{e^{j \theta} - e^{-j \theta}}{2j} \]
- Polar form
  \[ s := x + jy = r e^{j \theta} \]
- Magnitude
  \[ r = \sqrt{x^2 + y^2} \]
- Phase
  \[ \theta = \tan^{-1}(y/x) \]
  \[ s_1 = r_1 e^{j \theta_1}, s_2 = r_2 e^{j \theta_2} \]
  \[ s_1 s_2 = r_1 r_2 e^{j(\theta_1 + \theta_2)} \]
  \[ s_1 \overline{s_2} = \frac{r_1}{r_2} e^{j(\theta_1 - \theta_2)} \]
  \[ \frac{s_1}{s_2} = \frac{r_1}{r_2} e^{j(\theta_1 - \theta_2)} \]

Logarithm

- The logarithm of \( x \) to the base \( b \) is written \( \log_b x \)
- The logarithm of 1000 to the base 10 is 3, i.e., \( \log_{10} 1000 = 3 \)
- \( \log_{10} 10 = 1 \) \( \log_{10} 1 = 0 \)
- Properties:
  \[ b^{\log_b(x)} = x \]
  \[ \log_b(x^y) = y \log_b x \]
  \[ \log_b(x y) = \log_b x + \log_b y \]
  Why? \( x := b^z, y := b^w, \log_b(b^z b^w) = \log_b(b^{z+w}) \)
  \[ \log_b \left( \begin{array}{c} x \\ y \end{array} \right) = \log_b x - \log_b y \]
  \[ b^x = b^{x-y} \]
Laplace transform

- One of most important math tools in the course!
- Definition: For a function \( f(t) \) (\( f(t)=0 \) for \( t<0 \)),

\[
F(s) = \mathcal{L}\{f(t)\} := \int_0^\infty f(t)e^{-st}dt
\]

\( s: \) complex variable

- We denote Laplace transform of \( f(t) \) by \( F(s) \).

Summary & Exercises

- Prerequisites
  - Complex numbers, Logarithm, Laplace transform
  - Dynamics

- Next
  - Introduction

- Exercises
  - Buy the course textbook at the Bookstore.
  - Review today’s slides on complex numbers and logarithm
  - Read Chapter 1 and Appendix A, B of the textbook.