Welcome to the Fall 2019 Edition of ECE 602!

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Office Hours: MWF: 1:00--2:00pm in MSEE 233B or by appointment

Academic Integrity:

As a student at Purdue you are subject to the Purdue University Student Code of Conduct, which enjoins you to respect the highest standards of honesty and integrity. All work that you submit in this course must be your own; unauthorized group efforts are considered academic dishonesty. See the online brochure Academic Integrity: A Guide for Students for definitions and sanctions. Academic dishonesty is a serious offense which may result in suspension or expulsion from the University. In addition to any other action taken, such as suspension or expulsion, a grade of F will normally be recorded on the transcripts of students found responsible for acts of academic dishonesty. Students are encouraged to report academic dishonesty to the instructor directly, or to the Office of the Dean of Students. You may discuss assignments in a general way with other students, but you may not consult anyone else's written work.

Disability Resource Statement:

Purdue University is committed to an inclusive and welcoming experience for all students. To that end, the Disability Resource Center (DRC) is the office designated by Purdue to provide services, resources, and programs to facilitate equal access for disabled students, resulting in their full participation in curricular and co-curricular offerings.

The DRC serves disabled undergraduate and graduate students enrolled at Purdue's West Lafayette campus and Purdue Polytechnic Institute Statewide Programs, whether part-time or full-time (including students taking online courses). The DRC strives to proactively identify and remove barriers to access, promote inclusion and minimize the need for individual accommodations. The DRC also determines whether students are eligible for reasonable accommodation and, if so, the nature of the reasonable accommodation. The DRC does not test for, diagnose, or treat disability but relies on third-party documentation when determining accommodations.

Emergency Policies:

- In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. In such an event, information will be provided through Blackboard Learn.

- To report an emergency, call 911. To obtain updates regarding an ongoing emergency, sign up for Purdue Alert text messages, view https://www.purdue.edu/emergency/
- There are nearly 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the PUPD. If you feel threatened or need help, push the button and you will be connected immediately.
- If we hear a fire alarm during class we will immediately suspend class, evacuate the building, and proceed outdoors. Do not use the elevator.
- If we are notified during class of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in the basement.
- If we are notified during class of a Shelter in Place requirement for a hazardous materials release, or a civil disturbance, including a shooting or other use of weapons, we will suspend class and shelter in the classroom, shutting the door and turning off the lights.
- Please review the Emergency Preparedness website for additional information http://www.purdue.edu/ehps/emergency_preparedness/index.html

This page last updated on October 10, 2019

Course Objectives

ECE 602 is a core course in the area of Automatic Control. This area is concerned with controlling systems. Examples of systems are: cruise control systems in automobiles, flight control systems in airplanes, or temperature control systems in our homes. To control a systems is to is to make them behave in a desired manner using feedback mechanisms and controller. As one might expect from this broad description, control systems play a critical role in almost every aspect of our daily lives. Control systems are a core part of technologies such as mobile phones, the Internet, biomedical devices, manufacturing systems, the power grid, and autonomous drones and vehicles.

The objectives of this course are:

- The course aims to introduce the student to its subject, and then to allow the student to pass on to more advanced, specialized, and stimulating topics.
- To familiarize with the basic vocabulary, examples, and the general solution of the linear time-invariant and time-varying state models.
- To promote an in-depth understanding of the basic calculations, applications, and theoretical concepts of state variable approach to system theory.
- Introduce concepts of controllability, observability, and stability and show how these concepts are used to design controllers for some simple systems.

This page last updated on August 15, 2019

Prerequisites

Basic knowledge of signals and systems: Laplace transforms, Z-transforms, impulse response, transfer functions, convolution, difference equations, differential equations, etc. Minimal knowledge of basic circuit theory. Firm knowledge of linear algebra: matrices and vectors; eigenvalues and eigenvectors; rank of a matrix, column space, determinants, matrix inversion, etc. Some knowledge of complex variables including partial fraction expansions. Math 511 (first grad course in linear algebra), or equivalent, is a pre-requisite.
You can review your linear algebra at your leisure by viewing **video lectures** by Professor Gilbert Strang.

Course Outline

- Discussion of the control problem
- Modeling of dynamical systems
- Lumped systems
- Taylor linearization of nonlinear systems
- Solving the state equation
- Discretization
- Discrete systems
- Numerical simulation
- Stability analysis using the methods of Lyapunov
- Controllability and the pole placement problem
- Observability and observers

Welcome to the Home Page of the book

Systems and Control

by

Stan Żak

- Publisher's book webpage
- Errata
- Book Review

Solutions Manual

Instructor's Solutions Manual, with complete solutions to all of the end-of-chapter exercises, is available from the publisher to the instructors who adopt the book in their courses. Some of the exercises involve writing MATLAB programs. All of the MATLAB m-files of the end-of-chapter exercises are provided to the instructors who order a copy of the **Solutions Manual**.

Plots generated using MATLAB m-files available below

To run MATLAB m-files of examples solved in the book, place all the m-files into one directory on your computer. Launch MATLAB and make the MATLAB's **Current Directory** the one in which you place all the m-files. Type:

```
m_companion
```

This will produce a menu of push-button choices in a figure window. The menu items are book chapters that contain examples solved in the particular chapters. Clicking on a button will display a list of examples with MATLAB or SIMULINK files. Clicking on an example button will launch a corresponding program to be executed.

Please send comments or suggestions to Stan Żak: zak@purdue.edu

This page last updated on August 16, 2017

Grading Policy

A, A+	540--600
A-	500--539
B+	470--499
B	440--469
B-	410--439
C+	380--409
C	350--379
C-	320--349
D+	290--319
D	270--289
D-	250--269
F	<250

INSTRUCTIONS

- The assignments must be typed. Recommended package for typing math is LaTeX. A very friendly introduction to LaTeX is the book by Jane Hahn, Latex for Everyone.
- Clearly identify the steps you have taken to solve each problem.
- Your grade depends on the completeness and clarity of your work as well as the resulting answer.
- Make sure to cite completely all sources used.
- No electronic submissions will be accepted this semester.

- FunWork #1 due on September 10
- FunWork #2 due on September 23

In FunWork #2, you are asked to use MATLAB to animate the motion of the double pendulum. Here is an example of a MTLAB based animation that you can start with for this assignment. Here is a pdf of a section from Pratap's book on animation.

- FunWork #3 due on October 15
- FunWork #4 due on November 05
- FunWork #5 due on November 26

In FunWork #5, you are asked to use MATLAB to animate the motion of the controlled inverted pendulum on a cart. Here is an example of a MTLAB based animation that you can start with for this assignment. Here is a pdf of a section from Pratap's book on animation.

Test #1

October 01, Tuesday, 1:30--2:45pm, ME 2061

- This is a 75 minute duration exam
- Closed books, closed notes, no crib-sheets, no calculators

Test Coverage

- Constructing state-space realizations of given transfer functions
    1. Single-input single-output systems
    2. Multi-output single-input systems

- Computing the transfer function of a given state-space model
- Computing the matrix exponential
- Finding solutions to the state-space models
- Constructing a discrete-time model from a given continuous-time model
- Constructing a model of a networked controlled system
- The Kronecker product and its applications
- BIBO stability of continuous and discrete-time systems

Test #2

November 19, Tuesday, 1:30--2:45pm
ME 2061

- This is a 75 minute duration exam
- Closed books, closed notes, no crib-sheets, no calculators

Test Coverage

- Solving the Lyapunov equation for continuous and discrete-time systems
- Constructing robust linear controllers using Lyapunov's theorem
- Ackermann's formula for constructing state-feedback controller
- Controller form for linear time-invariant systems and its use in the feedback controller design
- Observer form for linear time-invariant systems and its use in the observer design
- Transfer function of the closed-loop system with the controller-observer compensator.