Systems and Controls
EE 4364-001, CRN-16475
EE 5390-012, CRN-19993
Fall 2022

Syllabus
Department of Electrical & Computer Engineering
The University of Texas at El Paso, El Paso, Texas 79968, USA
Ricardo von Borries
rvonborries@utep.edu

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Monday, August 22, 2022

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1 General Information

• **Course ID:** Systems and Controls, EE 4364-001, CRN-16475
  Special Topics in Electrical Engineering, EE 5390-012, CRN-19993
• **Time:** Monday and Wednesday, 1:30 pm – 2:50 pm
• **Lecture Room:** Engineering Building E340
• **Prerequisites:** EE2351 and EE2353 with a letter grade of “C” or better (by topic:
  differential equation, Fourier transform, Laplace transform, transfer function, block
  diagram)
• **Textbook:** G. F. Franklin, J. D. Powell, and A. Emami-Naeini. *Feedback Control of
• **Computational Software:** Matlab® [2], [3], and Simulink® [4]
• **Instructor:** von Borries – rvonborries@utep.edu
• **Office:** Engineering Building 313
• **Office Hours:** MW 6:00 pm to 7:00 pm (room 313 or Blackboard)
  F 4:00 pm to 5:00 pm (room 313 or Blackboard)
• **Version:** Monday, August 22, 2022

2 Description

*Systems and Controls* shows an introduction to the analysis and design of continuous-time
electrical and electromechanical control systems using three basic approaches: root locus,
frequency response, and state-space equations. Basic feedback structure is studied with
respect to stability, tracking, regulation, and sensitivity. *Systems and Controls* also presents
an introduction to digital controllers.
3 Textbook and Numerical Computation Software

*Systems and Controls* has two required resources: (1) the textbook by G. F. Franklin, J. D. Powell, and A. Emami-Naeini. *Feedback Control of Dynamic Systems.* Pearson, New York, NY, 8th edition, 2019 (available at UTEP’s bookstore); and (2) the software Matlab® for numerical computation and visualization developed by The MathWorks, Inc. [2, Matlab® on MathWorks]. If you don’t have Matlab® installed in your computer, you can get Matlab® from the Engineering Technology Center (ETC) at the Engineering building E351D, College of Engineering, located between the Engineering and Classroom buildings on the 3rd floor, [http://etc.utep.edu](http://etc.utep.edu), e-mail: etchelpdesk@utep.edu. Alternatively, you can have access to Matlab® at [https://my.apps.utep.edu/vpn/index.html](https://my.apps.utep.edu/vpn/index.html).

During the lectures, the instructor may use either Mathworks Matlab® and Simulink® or Wolfram Mathematica® to show numerical simulations and graphical visualizations in order to enhance teaching and learning of the concepts in *Systems and Controls*.

4 Student Outcomes

Ability to

- identify basic components of classical and modern control systems
- apply differential equations to describe the dynamic behavior of control systems
- apply the Laplace transform to analyze control systems
- represent and interpret control systems using block diagrams and signal flow graphs
- use state-space models to describe and analyze dynamic systems
- obtain the transfer function model from a state-space model
- describe the transient and the steady-state responses of control systems
- recognize the relationship between complex-plane root location and transient response
- analyze the stability of control systems: Bode, Nyquist, root locus, Routh-Hurwitz, state-space
- apply compensation to adjust frequency response, improve stability, improve error characteristics
- model, analyze, design, and implement control systems
- use computational software to model, simulate, and analyze control systems
5 Course Topics

1. CT signals and systems
   a. time-domain analysis
   b. system analysis using the Laplace transform (s-transform)

2. DT signals and systems
   a. time-domain analysis
   b. system analysis using the z-transform

3. Mathematical models of systems

4. State-space models

5. LTI state-space models

6. State observers and state feedback

7. Feedback control systems characteristics
   a. error signal
   b. sensitivity to parameter variations
   c. disturbance signals
   d. transient response
   e. steady-state error

8. Performance of feedback control systems
   a. second-order systems
   b. steady-state error

9. Stability of linear feedback systems
   a. Routh-Hurwitz stability criterion
   b. stability of state variable systems

10. Root locus method
    a. PID controllers
    b. negative gain root locus

11. Frequency response methods
    a. frequency response plots
    b. magnitude and phase diagrams

12. Stability in the frequency domain: the Nyquist criterion

13. Compensators
    a. phase-lead using root locus and Bode plot
    b. phase-lag using root locus and Bode plot
6 Evaluation

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Note that EE 4364 and EE 5390 are both introductory cross-listed courses on systems and controls: offered at the same time, on the same day, in the same room, with the same instructor, and using the same textbook; however, the content (theoretical level and extension of the material covered; and level and extension of the work required in the assessment of learning) may differ between the two courses and should be compatible with courses at senior undergraduate and first year graduate levels, respectively, EE 4364 and EE 5390.

Formulas are part of the material assessed in EE 4364 - EE 5390 and formula sheets are not allowed during EE 4364 - EE 5390 Comprehensive Final. Two important rules for the Comprehensive Exam in the classroom are: (1) closed textbook, notes and homework solutions; and (2) turned off electronic devices: calculator, computer, cell phone, smart watch, headphone, etc.

7 Grading

\[
A = 100 - 90\%, \quad B = 90 - 80\%, \quad C = 80 - 70\%, \quad D = 70 - 60\% \quad \text{and} \quad F = 60 - 0\%.
\]

8 Attendance

Class attendance is mandatory and will be monitored. Any student with more than two unexcused absences will be dropped out of the EE 3384.

9 Academic Integrity

Review and comply with the policy on academic integrity available at https://www.utep.edu/student-affairs/osccr/student-conduct/academic-integrity.html.

10 Comprehensive Final

There is no make-up exam for the Comprehensive Final.
11 Grade Assignment for Drops and Withdrawals

If you drop the course before the drop deadline, the grade is “W.” However, please note the following regulation stated in the UTEP academic catalog (http://catalog.utep.edu/grad/academic-regulations/registration-and-records/): “... if the student drops after the student-initiated course drop deadline, instructors will determine a grade of “W” or “F” for each course. A grade of W will be considered only under exceptional circumstances and must be approved by the instructor and department chair for the course. A student may need to petition the instructor for a grade of “W” in writing with the necessary supporting documentation.”

12 Office Hours

In addition to attending the lectures, plan to use office hours to get most out of EE 4364 - EE 5390. Feel encouraged to attend office hours and work with me on the textbook concepts and problems, Matlab® simulations, and preparing for the exams, homework, and projects. I can help you to learn Systems and Controls. You can use office hours to get more information on anything you are struggling with in class. During office hours, I can provide you with an opportunity (1) to carefully walk through an idea and (2) to get answered lots of questions that are specific to your needs, helping you to effectively learn the material. You can also use office hours to get more information on anything covered in class that triggered your interest, that you enjoyed. In addition to the regular office hours, you can contact me by email 24/7 with questions on the EE 4364 - EE 5390 material and I will try to reply and help you as soon as possible.

13 UTEP E-mail Account

To communicate with me, make sure your UTEP e-mail account is working fine. It is your responsibility to have a UTEP e-mail account working properly. By the end of the first week of classes, every student should have received at least one e-mail message from EE 4364 - EE 5390. If you detect a problem with your e-mail account (no EE 4364 - EE 5390 e-mail message received by the end of the first week of classes), you should request UTEP’s Help Desk assistance to fix the problem.

14 Use of Electronic Devices

The use of cell phones or electronic devices may pose a negative distraction (social media, internet, email) and disrupt classroom discussions. Phones must be silenced during classes, exams, or quizzes, and if you need to answer a call during a class, please step out of the classroom. You can use an electronic notepad for note taking only [5].
15 Accommodations and Support Services

If you have a disability and need classroom accommodations, please contact The Center for Accommodations and Support Services (CASS) at 747-5148, or by email at cass@utep.edu, or visit their office located in UTEP Union East, Room 106. For additional information, visit the CASS website at www.sa.utep.edu/cass.

16 Copyright Statement for Course Materials

Materials in this course, unless otherwise indicated, are protected by the United States copyright law. Materials are presented in an educational context for personal use and study and should not be shared, distributed, or sold in print or digitally, outside the course without permission.

17 References

The textbook by Dorf et al. [8] constitutes an alternative undergraduate textbook for systems and controls. Dorf’s textbook addresses an extensive list of classical and modern applications in systems and controls. The textbook’s content and organization is enhanced by a careful use of colors to highlight key concepts and produce engaging illustrations. Its extensive list of references organized by chapter is helpful to the one willing to gain deeper understanding of the material discussed in the text. Another helpful resource in the textbook is the use of tables summarizing important information such as: (a) governing differential equations for ideal electrical and mechanical elements; (b) transfer functions of common dynamic elements and networks; and (c) plots for typical loop transfer functions. Both Dorf’s [8] and Franklin’s [1] textbooks are equivalent outstanding references for undergraduate courses on systems and controls.

The textbooks by Lathi et al. [9] and Oppenheim et al. [10] are two of the most insightful and enlightening electrical engineering undergraduate references on signals and systems. Both textbooks contain basic concepts used in the present course on Systems and Controls, including signals and linear time-invariant systems, the Laplace transform, the Fourier transform, and the z-transform. The two textbooks study signals and systems in the continuous-time and discrete-time, and they include sampling theory connecting the continuous-time and the discrete-time representations of signals and systems. The textbook by Lathi et al. [9] includes an introductory chapter on the basic math needed for signals and systems (complex numbers and complex exponentials, vectors, matrices, and elementary Matlab® operations) and it includes also an introductory chapter on state-space analysis, which provides a system’s internal description commonly used in systems and controls. The textbook by Oppenheim et al. [10] includes a chapter on the basic theory of linear feedback systems, addressing basic concepts studied in Systems and Controls (including feedback, root-locus, stability, gain and phase margins). The aforementioned textbooks are not required for the present course on Systems and Controls but they represent key references for one willing to review, complement, or learn fundamental concepts studied in undergraduate signals and systems courses, in the continuous-time or in the discrete-time.
References Sorted by Order of Appearance


### A Calendar

EE 4364 and EE 5390, MW 1:30 pm – 2:50 pm

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- **Labor Day, UTEP Closed**: September 5, Monday
- **Course Drop/Withdrawal Deadline**: October 28
- **Thanksgiving, UTEP closed**: November 24 to 25
- **Comprehensive Final**: December 7, Wednesday, 4:00 pm to 6:45 pm
  All the material
EE 4364/5390 – Systems and Controls

Description  Introduction to the analysis and design of continuous-time electrical and electromechanical control systems using three basic approaches: root locus, frequency response, and state-space equations. Basic feedback structure is studied with respect to stability, tracking, regulation, and sensitivity.

Course activities enriched by inverted pendulum kit experiments and Matlab® simulations.

Prerequisite  EE 2351+2353 (with C or better).

Term      Fall 2022    Time       MW 1:30–2:50 pm

Instructor  R. von Borries, PhD

References

