

# ECE 446: Design of Feedback Control Systems

## Spring 2019

**Instructor:**

Dr. Sean Phillips

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Office Hours: By appointment

**Class Time/Room:** T/Th 5:00 - 6:15 pm, ECE 311

**ECE 446 Course Description:** (UNM Course Catalog) Modeling of continuous and sampled-data control systems. State-space representations. Sensitivity, stability and optimization of control systems. Design of compensation in the frequency and time domain. Phase-plane and describing function design for non-linear systems and laboratory design project.

**Prerequisites:** ECE 345/ME 380 Introduction to Control Systems

**Course Web Page** <https://learn.unm.edu>

**Textbook Information** No textbook is required for this class. Notes will pull from the following books:

1. Norman S. Nise, *Control Systems Engineering* Wiley, 7th ed, 2015
2. Karl J. Astrom and Richard M. Murray. *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, 2008.  
(url: <http://www.cds.caltech.edu/~murray/amwiki/>)
3. Gene Franklin, J. David Powell and Abbas Emani-Nachi *Feedback Control of Dynamic Systems*, 6th ed, Prentice Hall 2010.
4. Chi-Tsong Chen *Linear System Theory and Design*, 4th ed, Oxford University Press 2012

**Grading:**

- Homework (20%)
- Exams ( $2 \times 25\%$ )
- Lab Reports (30%)

**Tentative List of Topics:**

1. Introduction of Feedback Control Systems
2. Linearization

3. Transfer Functions and State-space Representation
4. Stability, Steady-state Error, and 2nd Order System Characteristics
5. Control Design via Root Locus
6. Control Design via Frequency Response
7. Proportional Integral Derivative (PID) Control
8. State-space Analysis: State-Transition Matrices, Stability, Controllability and Observability
9. State Feedback and Linear Quadratic Regulator (LQR)
10. Introductions to Nonlinear Control, Digital Control and Hybrid Systems

- **Homework Policy:**

- There will be 4-6 homework sets. Homework is due one week after it is assigned unless otherwise noted. Submit a professional document with legible handwriting. Latex write-ups are always appreciated and add to clarity. Late homework will **not** be accepted for any reason.
- You may discuss the solution procedure for any problem with either your friends or the instructor, but the final submitted report must reflect your personal thought processes and efforts. Solutions keys will be provided for the homework sets. If you have any questions, please do not hesitate to email me for an appointment after class times. Please do not wait until the end of the semester.
- Some of the homework assignments may require the use of Matlab/Simulink which is available in the computer labs.

- **Exam Policy:**

- Exams may be given in-class or as a take home assignment. No makeup exams will be allowed. Dates TBD.

- **Attendance:** Students are responsible for any information presented in class, while attendance is not mandatory it will be beneficial.

- **Academic Integrity:** Each student is expected to maintain the highest standards of honesty and integrity in academic and professional manners. The University reserves the right to take disciplinary action, up to and including dismissal, against any student who is found guilty of academic dishonesty or otherwise fails to meet these standards.

- **Access to Education:** Qualified students with disabilities needing appropriate academic adjustments should contact the instructor as soon as possible to ensure your needs are met in a timely manner. For information on assistive technology available for student use and addition information on services available through Student Accessibility Services, see <http://as2.unm.edu/>.

- **Audit:** A student may register in this course as an *audit* status, provided permission of the instructor. A student has the first four weeks of the semester to change a course to audit status. No changes in audit status will be processed after the fourth week of class.

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- **Privacy and UNM Learn:** UNM Learn automatically records all students' activities, including, your first and last access to the course, the pages accessed, the number of conferencing messages you have read and sent, chat room discussions, and posted discussion topics. This data is accessed by the instructor to evaluate class participation and to identify students having difficulty using UNM Learn functionality.
  - **Incompletes, Withdrawals, and Drops:** This course falls under all UNM policies for the last day to drop courses, etc. Please advise the academic calendar at <http://registrar.unm.edu> for dates and deadlines.
  - **Course Evaluations:** You will be asked to complete an online course and instructor evaluation. These evaluations will provide useful information to improve this course.
  - **Syllabus Changes:** The write is reserved to modify the Syllabus at any time through out the semester, modifications will be announced in class. Please make sure you have the most up to date version.