# Portland State University

## Electrical & Computer Engineering

## -ECE 311 Feedback and Control-

**Credit Hours:** 4

**Prerequisites:** EE 223, Math 256.

**Instructor:** Ross Gadient, Ph.D. **Email:** gadient@pdx.edu

**Office Hours:** TBD

**Objectives:** Classical control concepts for continuous-time, time-invariant, linear systems. Signal flow graphs. Routh-Hurwitz criterion, steady-state and root-locus analysis methods. Compensation methods derived from Bode plots. Software assignments for design and verification of controllers.

**Textbook:** Ogata, K., "Modern Control Engineering," 5th Ed., Pearson Prentice Hall, 2009 (required)

**References:** Ogata, K., "Matlab for Control Engineers," Pearson Prentice Hall, 2008

"FE Reference Handbook," National Council of Examiners for Engineering and Surveying (NCEES), http://ncees.org/exams/study-materials/download-fe-supplied-reference-handbook/

**Instruction:** The class will meet twice per week for 100 minutes of lecture. Homework will be assigned roughly every week. Select homework problems will be graded. Late homework will not be accepted. A mid-term exam will be administered during the fifth week of the term. A final exam will be administered at the end of the term.

**Grading and Scale:**

Home Work - 50%, Mid-Term - 25%, Final - 25%

| A | B | C | D |
|---|---|---|---|
| > 90% | > 80% | > 70% | > 60% |

Instructor discretion may be applied to the boundaries between letter grades.

If you have a dispute regarding the grading of an assignment, follow the instructions listed in the Grade Dispute Form, which is posted in D2L. Do not ask the instructor or TA to review a dispute unless you use this process.

**Course Objectives:**

Upon completion of ECE 311, a student should be able to:

1. Understand and apply block diagrams
2. Identify and apply fundamental compensator architectures
3. Understand and derive response of 1st- and 2nd-order systems
4. Understand and apply the Routh stability test criterion
5. Determine steady state error of a tracking system
6. Understand and apply pole-zero plots and root locus plots
7. Understand and apply Bode plots; gain and phase margins
8. Design compensation systems using Bode plots

**Course Content:**

1. Control systems representation
2. 1st- and 2nd-order systems
3. Stability criteria, system performance
4. System performance, steady state error
5. Design using root-locus plots, poles & zeros
6. Nyquist stability criterion
7. Bode and Nyquist plots
8. Feedback system analysis and design using Bode plots
9. Determination of plant models
10. Design of various compensators (PI, PD, PID, lag, lead, lag-lead)

**Related ABET Student Outcomes**

(a) an ability to apply knowledge of mathematics, science, and engineering
(e) an ability to identify, formulate, and solve engineering problems
(g) an ability to communicate effectively
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**Lecture Schedule:**

| | **Topics** | **Reading** | **Due** |
|---|---|---|---|
| Week 1 | Intro to Feedback | 1-28 | |
| | Math Models, Block Diagrams, Feedback | | |
| Week 2 | Classifications of Compensators | 159-178 | HW#1 |
| | 1st and 2nd Order Systems | 179-182 | |
| Week 3 | 2nd and n-th Order Systems | 72-85 | HW#2 |
| | EE Control Systems | | |
| Week 4 | FVT, Zeros, Routh stability criterion | 212-217 | HW#3 |
| | System type | 218-230 | |
| Week 5 | Root Locus | 269-307 | HW#4 |
| | Root-locus design | 308-346 | |
| Week 6 | **Midterm Exam** | | |
| | Bode plots | 403-426 | |
| Week 7 | Stability margins, Nyquist plots | 427-439 | HW#5 |
| | Nyquist stability criterion | 445-462 | |
| Week 8 | Determination of TFs | 470-476, 486-492 | HW#6 |
| | Common Industrial Compensators, advanced | | |
| Week 9 | **Memorial Day** | | |
| | Compensator design: PI, Lag | | HW#7 |
| Week 10 | Compensator design: Lead, Lag-Lead, | | |
| | Compensator design: Rate-Feedback, PID | | HW#8 |
| Week 11 | **Final Exam** | All Above | |