# Course Details

**Time and Place:**

T,R 12:30 PM to 1:50 PM O'Brian 109

**Office Hours:**

Contact me via e-mail:

Office: 1009 Furnas Hall, Office Tel: 645-1428.

The TA for the course is Derek Bourabah and he can be reached derekbou@buffalo.edu
The Lab instructor for the course is Youngjin Kim and he can be reached by ykim35@buffalo.edu. His office hours for questions related to the Lab for MAE 543 will be announced.
MAE 543 Labs will be in Furnas 810/811
---
Office Hours: Tuesday 3:30 - 5:30 PM (Bell 233).
Office Hours: Wed. 3:00 - 3.50 PM (Bell 232).
Recitation: Wed. 4:00-4:50 PM in Room O'Brian 109.
Final Exam: December Dec., 15, 2022, 11:45-2:45 PM. Room O'Brian 109.

**Introduction:**

Automatic control has touched every aspect of our lives. Every engineering discipline has benefited from control technology. For instance, Civil engineers have integrated active mass dampers to reduce the inter-story drift of buildings when excited by an seismic event, Aerospace engineers have developed control technology which can permit a space vehicle to rendezvous with a target many light days from its launch point, Mechanical engineers have exploited control to design CNC machines which can carve complex shaped turbine blades, Electrical engineers have designed very precise servo-motors which permit rapid fastening of leads to an integrated chip. With the interdisciplinary nature of control, one can only foresee its influence on an engineer's life, increase with time.

**Objectives:**

The goal of this course is to provide an introduction to the design and analysis of control systems. This course will only consider linear systems which will permit a control designer to exploit frequency-domain and time-domain tools to study control systems. The foundation of all control theory is stability. Methods to analyze stability and degrees of stability will be discussed. The chronologic order of topics that will be discussed are: (i) Review of Laplace Transforms, (ii) Mathematical modeling of dynamic systems, (iii) time-response analysis, (iv) Root-Locus analysis, (v) Frequency response analysis, and (vi) P, PD, PI, and PID control design. At the end

of the course, the students will have the ability to represent a dynamic system in a standard block diagram form which is commonly used by control engineers, analyze the stability of the open and closed loop system and synthesize a controller to meet a desired objective. Basic knowledge of mechanics, ordinary differential equations, Laplace transforms and MATLAB is assumed. Lack of exposure to MATLAB should not be a debilitating factor, since the learning curve for this software is not steep.

**Prerequisites:**

MAE340.

**Textbook:**

Ogata, Katsuhiko, *Modern Control Engineering: Fourth Edition*, Prentice Hall PTR, Upper Saddle River, New Jersey 07458, 2002.

**Homework:**

Homeworks will be periodically assigned, which are due one week from the day they are assigned. Late homeworks will not be accepted and solutions to the homeworks will be posted.

**Grading:**

| | |
|---|---|
| Virtual Lab | 20%,<br>(10% Graduate students) |
| Labs TBD (Graduate students) | 10% |
| Homework | 20% |
| Quiz 1 | 5% (Tentatively Week 6) |
| Mid-Term Exam | 25% (Tentatively Week 10) |
| Quiz 2 | 5% (Tentatively Week 13) |
| Final Exam | 25 % |

**Grade Tables:**

The grade values required to earn a given grade may be lowered at the discretion of the Instructor; they will not be raised. There is no D+ grade.

Undergraduate Students

| Letter Grade | % Grade |
|---|---|
| A | 85+ |
| A- | 78-85 |
| B+ | 70-78 |
| B | 66-70 |
| B- | 63-66 |
| C+ | 59-63 |
| C | 54-59 |
| C- | 50-54 |
| D | 40-50 |
| F | 0-40 |

Graduate Students

| Letter Grade | % Grade |
|---|---|
| A | 93+ |
| A- | 86-93 |
| B+ | 79-86 |
| B | 72-79 |
| B- | 67-72 |
| C+ | 61-67 |
| C | 57-61 |
| C- | 53-57 |
| D | 45-53 |
| F | 0-40 |

**References:**

Kuo, Benjamin, *Automatic Control Systems: Seventh Edition* , Prentice Hall PTR, Upper Saddle River, NJ 07458, 1995.
Driels, Morris., *Linear Control Systems Engineering* , McGraw Hill, New York, 1996.
Dorf, Richard, C., and Bishop, Robert, H., *Modern Control Systems: Seventh Edition* , Addison-

Wesley, Reading, Massachusetts, 1995.
Ogata, Katsuhiko, *Designing Linear Control System with Matlab* , Prentice Hall, Englewood Cliffs, NJ 07632, 1994.
Leonard, N. E., and Levine, W. S., *Using Matlab to Analyze and Design Control Systems* , Benjamin/Cummings Publishing Company, Inc., Redwood City, CA, 1995

**Important Dates**

- 
  - Aug. 29 Classes begin
  - Sep. 6 Last day to drop/add
  - Nov. 11 Last day to resign course with an "R" grade.
  - Nov. 23 - Nov. 26 Fall Recess
  - Dec. 9 Last day of classes
  - Dec. 10- Dec. 11 Reading Days
  - Dec. 12 - Dec. 19 Final Exams

---

**For help with library resources, contact:**

**Erin Rowley**
**Engineering Librarian**
**Science & Engineering Library**
**119 Lockwood Memorial Library**
**University at Buffalo, State University of New York**
**email: epautler@buffalo.edu**
**phone: 716-645-1369**

---

# Learning outcomes

The student who successfully completes the course shall have the necessary knowledge to be able
to analyze and design a control system.

- Explain basic concepts in control system such as open-loop and closed-loop control,
stability, transient and steady state response.
- From a linear differential equation produce a dynamic model, i.e. transfer function for
a system. (includes block diagram reduction)
- Characterizing transient and steady state behavior, gain and phase margins.
- Analyze a system, i.e., stability, (Routh Hurwiztz, root-locus, Bode diagram, Nyquist
charts)
- Design a controller for the system (P, PD, PID, lead, lag).