University of California at Berkeley
Department of Mechanical Engineering

ME 233: Advanced Control Systems II **Spring 2016**

URL: http://berkeley-me233.github.io

ME233 discusses advanced control methodologies and their applications to engineering systems, including but not limited to: Linear Quadratic Optimal Control, Stochastic State Estimation, Kalman Filters, Linear Quadratic Gaussian Problems, Loop Transfer Recovery, System Identification, Adaptive Control and Model Reference Adaptive Systems, Self Tuning Regulators, Repetitive Control, Disturbance Observers.

Instructor	Tony Kelman	
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Lectures	Tu, Th 3:30-5:00 in 150 Goldman School of Public Policy
Discussion	W 4:00-5:00 in 3109 Etcheverry Hall

Grading	Midterm 1	20% (open one page summary sheet)
Scheme	Midterm 2	20% (open one page summary sheet)
	Final Exam	40% (open notes)
	Homework	20% (Group discussion encouraged, but each student must write up homework individually. Indicate with whom, if anyone, you have discussed the homework problems.)

Class Notes

ME233 PowerPoint Lectures
(These will be made available on the course website)

ME233 Class Notes by M. Tomizuka
(This can be purchased at Copy Central, 2483 Hearst Avenue)

Tentative Schedule (Subject to change):

Week	Topics
1	Dynamic Programming; Discrete-Time LQ optimal control; Probability Theory—Sample Space, Random Variable, Cumulative Distribution and Probability Density Functions
2	Probability Theory—Random Processes, Correlation Function, Spectral Density
3	Least Squares Estimation; Stochastic State Estimation (Kalman Filter)
4	Stochastic Estimation, Kalman Filter (continued)
5	Linear Stochastic Control (Linear Quadratic Gaussian (LQG) Control)
6	Linear multivariable control; Loop Transfer Recovery
7	Frequency shaped LQ; **Midterm Examination I**
8	Tracking Control; Feedforward and Preview Control
9	Internal Model Principle and Repetitive Control
10	Disturbance Observer
11	System Identification and Adaptive Control; **Midterm Examination II**
12	Parameter estimation algorithms
13	Stability analysis of adaptive systems; Minimum Variance Regulation
14	Self-tuning regulators; Robustness of adaptive control systems

References:

Probability

- D. P. Bertsekas*, Introduction to Probability*, Athena Scientific
- R.D. Yates and D.J. Goodman, *Probability and Stochastic Processes,* second edition, Willey.
- K. Poolla, *Probability Notes.* The PDF file can be downloaded from the ME233 website
- J. Walran, *EECS126 class notes*. The PDF file can be downloaded from the ME233 website

Linear Quadratic Optimal Control

- B.D.O. Anderson and J.B. Moore, *Optimal Control: Linear Quadratic Methods*, Dover Books on Engineering (paperback), 2007. A PDF can be downloaded from: http://users.rsise.anu.edu.au/%7Ejohn/papers/index.html

- Frank L. Lewis, Vassilis L. Syrmos, *Optimal Control*, Wiley-IEEE, 1995.

- E. Bryson and Y-C. Ho, *Applied Optimal Control: Optimization, Estimation, and Control*, Wiley

Stochastic Control Theory and Optimal Filtering

- R. Grover Brown and P. Hwang, *Introduction to Random Signals and Applied Kalman Filtering,* Third Edition, Willey
- Frank L. Lewis, L. Xie and D. Popa, *Optimal and Robust Estimation,* Second Edition CRC
- M. Grewal and A. Andrews, *Kalman Filter, Theory and Practice,* Prentice Hall
- B.D.O. Anderson and J.B. Moore, *Optimal Filtering*, Dover Books on Engineering (paperback), New York, 2005. A PDF can be downloaded from: http://users.rsise.anu.edu.au/%7Ejohn/papers/index.html
- K.J. Astrom, *Introduction to Stochastic Control Theory,* Dover Books on Engineering (paperback), New York, 2006.

Adaptive Control

- Astrom, K. J. and Wittenmark, B., *Adaptive Control*, Addison Wesley, 2nd Ed., 1995.
- G.C. Goodwin and K.S. Sin, Adaptive *Filtering Prediction and Control*, Prentice Hall, 1984.
- S. Sastry and M. Bodson, *Adaptive Control: Stability, Convergence, and Robustness,* Prentice Hall, 1989. (Book can be downloaded from http://www.ece.utah.edu/~bodson/acscr/)
- M. Krstic, I. Kanellakopoulos, and P. V. Kokotovic, *Nonlinear and Adaptive Control Design*, Willey.