**University of California at Berkeley**

**Department of Mechanical Engineering**

**ME 233: Advanced Control Systems II Spring 2012**

**URL: http://bspace.berkeley.edu/**

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| **Instructor** | Richard Conway  Office Hours:  Office:  Email: | M, W 11:00-12:30  5121 Etcheverry Hall  [rconway345@berkeley.edu](mailto:rconway345@berkeley.edu) |
|  |  | |
| **Teaching Assistant** | (none) | |
|  |  | |
| **Lectures** | Tu, Th 3:30-5:00 in 1165 Etcheverry Hall | |
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| **Discussion** | TBD | |
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| **Grading Scheme** | Midterm 1  Midterm 2  Final Exam  Homework | 20%  20%  40%  20% |
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| **Class Notes** | ME233 PowerPoint Lectures  (These will be made available on bSpace)  ME233 Class Notes by M. Tomizuka, Part I  (This can be purchased at Copy Central, 2483 Hearst Avenue)  ME233 Class Notes by M. Tomizuka, Part II  (This will be made available on bSpace) | |

**Tentative Schedule** (Subject to change):

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| Week | Topics |
| 1 | Probability Theory—Sample Space, Random Variable, Cumulative Distribution and Probability Density Functions |
| 2 | Probability Theory—Random Process, Correlation Function, Spectral Density |
| 3 | Least Squares Estimation; Stochastic State Estimation (Kalman Filter) |
| 4 | Kalman Filter (continued) |
| 5 | Properties of the Kalman Filter |
| 6 | Dynamic Programming; Discrete-Time LQ problem; Properties of LQ Systems—Return Difference Equality, Robustness, Closed-Loop Eigenvalues and Symmetric Root Locus |
| 7 | Linear Stochastic Control (Linear Quadratic Gaussian (LQG) Control)  **Midterm Examination I** |
| 8 | Minimum Variance Regulation |
| 9 | Tracking Control; Feedforward and Preview Control |
| 10 | Internal Model Principle and Repetitive Control |
| 11 | System Identification and Adaptive Control  **Midterm Examination II** |
| 12 | Parameter estimation algorithms |
| 13 | Stability analysis of adaptive systems |
| 14 | Self-tuning regulators |

# 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.