Instructor: Dr. Prabir Barooah  
Office: MAE-A 322  
E-mail: pbarooah at ufl.edu  
Office Phone: 352.392.0614

Class time: period 4 (10:40-11:30 am) MWF  
Class location: MAE-B 229  
Office Hours: 11:30 am - 12:30 pm, MWF

Course website
Please check the course website regularly for updates and announcements until classes begin:
http://humdoi.mae.ufl.edu/~prabirbarooah/EML6352Fall2011.html
This is a temporary website which will be used only until classes begin. After that, use of this website will be discontinued, and all updates/announcements will be available in the course website in E-learning: https://lss.at.ufl.edu/.

Teaching Assistant
TBD  
TA office hours: TBD

Course Outline
The purpose of this course is twofold: (1) provide a firm background in parameter and state estimation methods, and (2) provide training on how to (and how not to) apply them in practice. Relevance to engineering applications and fields such as control and robotics will be illustrated through examples and projects. The first few weeks of the course will be an intense crash course in probability, in which concepts such as random variables, density functions, moments, etc. will be reviewed. After that, we will start with the problem of estimating a vector of parameters \( \theta \in \mathbb{R}^n \) from noisy measurements \( z = H\theta + \epsilon \), where \( \epsilon \) is a measurement noise vector. Engineering applications where the problem can be cast in this form will be discussed. We will then examine the general problem of estimating one random vector given the measurement of another. The second part of the course will be on the state estimation problem, in which the state \( x_k \) of a dynamic system \( x_{k+1} = f_k(x_k, u_k, w_k), y_k = h_k(x_k, n_k) \) is to be estimated, where \( w_k \) and \( n_k \) are noise affecting the states and measurements. We will devote some time deriving the Kalman filter in detail, which provides a solution to the state estimation problem when the dynamics are linear. We will also study a few extensions of the Kalman filter to non-linear systems, and particle filtering methods.

Topics to be covered:
Review of linear algebra: least squares solution of linear equations and its application to parameter estimation of dynamical systems from input-output data.

Review of Probability and Random Variables. Combinatorics, Probability spaces, random variables, density functions, moments (esp. mean and variance), concepts related to multiple random variables, joint density functions, independence, conditional density, etc.


**Course prerequisites**

Very strong mathematical skills. The three main topic areas that the course draws from are probability theory, linear algebra, and linear systems theory. The following courses are useful to have under your belt: EEL 5544 (ECE: Noise in Linear Systems), MAD 6406 (MATH: Numerical Linear Algebra), and either EML 5311 (MAE: Control System Theory) or EEL 5182 (ECE: State Variable Methods). You need not have done any of them, but some familiarity with linear algebra and linear systems is assumed. Familiarity with probability and random variables will *not* be assumed, instead I'll devote the first part of the course to that topic.

**Evaluation criteria**

Grading will based on home-works and in-class quizzes (15%) two exams (30% each) and a final project (25%). This is subject to change.

The dates of mid terms will be announced later. In class quizzes will be announced a day or two ahead of time. The mid-terms are budgeted at 45 minutes each. The final projects will be evaluated based on a 30 minute presentation. You can pick your project topic.

**Textbook:**

There is no required textbook for this course. The following are recommended books/resources on estimation:


3. Arthur Gelb (Editor), *Applied Optimal Estimation*. (very good text for state estimation of dynamic systems if you have some familiarity with the material, not recommended for beginners.)


This course makes extensive use of (1) probability, (2) linear algebra, and (2) linear systems theory. The following are recommended as references for the first two topics:

**Probability and random variables**


**Linear algebra**


**Make up exams etc.**

If you have to miss and exam, you must see the instructor and make arrangements in advance unless an emergency makes this impossible.

**Computers, Calculators etc.**

MATLAB is required to solve some home work problems, and to understand the material toward the end of the class (for instance, Markov chain Monte Carlo sampling). You may want to purchase the student version of MATLAB. The full version (including many toolboxes) is available in the MAE Undergraduate Computer Lab in NEB 109, and at CIRCA computer clusters campus wide (labs.circa.ufl.edu).

You should bring a calculator to class and to the exams. Cellular phones, PDAs, etc. will NOT be allowed in place of calculators.

**Students with Disabilities**

The University of Florida provides high-quality services to students with disabilities, and we encourage you to take advantage of them. Students with disabilities needing academic accommodations should 1) Register with and provide documentation to Disability Resources (392-1261), and 2) Bring a letter to the instructor from this office indicating that you need academic accommodations. Please do this as soon as possible, preferably within the first week of class.

**Academic Integrity**

All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. Academic honesty is therefore taken quite seriously in this class.