EC3410 - Discrete-time Random Signals

- **Instructor:** Monique P. Fargues, Span 456, fargues@nps.edu, *2859, office hours: posted or by appointment

- **Course Goals:** This course provides the foundation needed to study and extract information from random signals which commonly occur in engineering problems. Concepts are applied to various scenarios commonly found in modern electronic systems such as evaluation of evaluation of sensor data properties, target distance identification, signal/information extraction, communication signals detection, transmission channel equalization, biometrics, and network traffic flow anomaly detection.
- **Texts:** Two textbooks are indicated as references to the course. These texts are good references which will provide you with extensive resources. However, these texts have much more material in them than we have time to cover in the course. I teach mostly from my notes (which you need to download prior to class) and I refer to the texts for proofs or extensions I don't have time to cover in the classroom and for HW problems, as appropriate. Copies of the texts are also available on reserve at the library.

  (1) Discrete Random Signals and Statistical Signal Processing, C.W. Therrien
  (2) Statistical and Adaptive Signal Processing, D. Manolakis, V. Ingle, S. Kogon, Artech House, 2005
  (new: electronic copy available from the library)

- **Main References**:

[1] *Random Data, Analysis, Measurement and Procedures*, 3rd ed. J. Bendat, A. Piersol, Interscience, 2000
[2]: http://www.cs.mcgill.ca/~mcleish/644/normal.html [dead link as of 06/14]
[3] : Mathworks MATLAB tutorials: http://www.mathworks.com/academia/student_center/tutorials/launchpad.html
[4]: *Probability and Statistics for Engineers*, 6th ed., Johnson, Prentice-Hall
[5]: *Applied Statistics for Engineers and Scientists*, Petrucelli et al, Prentice-Hall.
[6]: *Performance Evaluation of Computer and Communication Systems*, J-Y. Le Boudec, EPFL, http://perfeval.epfl.ch/
[7]: *NIST/SEMATECH Engineering Statistics Handbook*, http://www.itl.nist.gov/div898/handbook/

- **Course outline:**

Review of random concepts and basic pdfs, random variable, statistical independence, transformation of random variables, concepts of correlation, cross-correlation and covariance
Central limit theorems
Random processes: Bernouilli, random walk, Gaussian processes (1- and N-dimensional)
Estimators: mean and variance
Normality check, applications to signal analysis and characterization
Confidence interval definition and applications of the confidence interval concept to verify/accept/reject hypotheses
Statistical characterization of random signals: IID, stationary & wide sense stationary (wss) concepts, jointly wss, ergodicity, periodicity, cyclostationarity
Correlation function and matrix, white & colored noise definition
Power spectral density
Principal Component Analysis & applications (face recognition, network anomaly detection)
Linear transformations of random processes
Matched Filter (applications to radar/communication scenarios)
FIR Wiener optimal filtering (applications to communication system detectors, communication channel equalization, system identification, noise cancellation, spatial filtering for smart antennas),

- **Grades:** 2 tests, each worth 25%; assignments: worth 40%, class participation: 10%

- **HWs:** A few problems will be assigned on a regular basis to apply the various concepts covered in the classroom. HWs will not be collected; however they constitute an essential part of the learning process for the course. You are responsible for working on the problems as they get assigned to facilitate the understanding of the concepts covered in class. Solutions will be made available.

- **Exams:**
  - Test 1 will be closed books/notes. You will be allowed to bring in 2 one-sided (8.5*11") sheets on which you may write whatever you feel may be useful to you. Tables will be provided if needed.
  - Test 2 will require the use of MATLAB and will have a take home portion. The take home portion will operate

under the following protocol: "**This is a take-home exam. Open books/notes. You may not discuss this test via any form of communication (written, oral, or computer), or exchange any type of information related to this test with anyone, except the instructor. By turning in your test, you acknowledge having read, agreed to, and followed the above instructions. Violations of this protocol are violations of the Honor Code and will be processed as such."**

- **Test schedule**: early August, early September, no final.

- **Class notes:** Copies of partially filled-in PowerPoint notes used during classes will be made available electronically in the SAKAI course account in the folder *Resources/NotePacks & Syllabus*. Data and other material needed during the course will also be made available in the SAKAI course account. You will receive an e-mail notification when available. You are responsible for printing and bringing class notes to class as needed. I will **not** have copies available in class.

- **Computer Lab Periods / Computer-based Assignments:**
  - MATLAB will be extensively used during the course. You should be familiar with the software before you take this course or will be expected to learn it on your own. MATLAB tutorials can be found online, for example, see references [2, 3]. A good recommended MATLAB tutorial book is "Mastering MATLAB 7," by D. Hanselman & B. Littlefield.
  - Some of the work related to computer based assignments is conducted during assigned lab periods and lab reports turned in a few days after the lab. These sessions are designed to apply concepts discussed in the classroom within a few days after they are presented. Thus, you will be expected to
    1. Review course material and be current on material pertinent to the lab assignments BEFORE you come to the lab sessions to insure you get the most out the time spent there,
    2. Turn in lab work within a few days after the lab session.
  - You are encouraged to discuss your work with fellow classmates or the instructor during lab sessions. However, the work turned in (report and software implementation) should be your own work only. Data and code from other students are not to be used in reports. Work turned in which is found to violate these guidelines will be considered a violation of the academic honor code and processed as such (See Section 218 of the student handbook for further details).
  - You are expected to curtail e-mail or web surfing activities during these sessions.
  - Late reports will not be accepted unless pre-approved by the instructor and for special circumstances only.

- **Academic Honor Code**: Students must follow the academic honor code at all times. Work turned in (tests, assignments, project reports, and all software implementations) should be your own work only.