BME 1452: Signal Processing - Fall 2015

A course targeted towards engineering students collecting experimental data in graduate-level research projects.

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2/ Lecture Times: Wednesday, 3:00 – 5:00 PM

3/ Lecture Location: MC306 (formerly MC310)

4/ Course Organization: The course will be divided into two main modules:

a) Analysis of systems (Lectures 1-6)
b) Random signals, Power Spectra, filtering and adaptive systems (Lectures 7-13).

6/ Grading Scheme:

a) Assignments – 10%
b) Midterm – 20% (Held during first half of lecture 7)
c) Term project – 30%
d) Final exam – 40%

Course web-site: **http://www.mie.utoronto.ca/ftp/guest2**
username: asguest2
password: B8101

7/ Detailed Lecture Schedule and Topics (subject to modification):

No.	Date	Instructor	Reference	Topic
1	Sept 16	Sinclair	Oppenheim chapters 1,2; Hsu chapters 1,2; Hayes chapter 1.	Overview of systems (Biomedical/mechanical), key components, signal characteristics. Continuous and discrete-time signals. Frequency content. Linear time-invariant systems. Linear constant-coefficient differential equations delta functions. Impulse response. Impulse response. Signal convolution. Definition of Fourier Transform.
2	Sept 23	Sinclair	Oppenheim chap's 3-7, 9, 10. Hayes chap's 2-7; Hsu chap's 3-6	Fourier Transform. Signal convolution and de-convolution in time and frequency domains. Data acquisition systems. Phase plots. Periodic and aperiodic signals; discrete and continuous signals in the frequency domain. Examples of DFT, DTFT. Parseval's theorem. Signal sampling and windowing: distortions and strategies. Nyquist theorem. FFT. Optimization of signal acquisition parameters.
3	Sept 30	Sinclair		
4	Oct 7	Sinclair		
5	Oct 14	Sinclair	Hayes chap's 2-7; Hsu chap's 3-6	Signal Modulation. Selection of signal windowing kernel. Signal scalloping. Introduction to low-pass signal filters.
6	Oct 21	Sinclair	Hayes chap's 2-7; Hsu chap's 3-6	Noisy signals. auto-correlation and cross-correlation functions. signal chirps. analytic signal. Applications.
7a	Oct 28	Sinclair	Hayes chap's 2-7; Hsu chap's 3-6	Mid –Term (first half of lecture period). It will be based only on lectures delivered by Sinclair up to October 21. (1 hour)
7b	Oct 28	Eizenman		Term Projects
8	Nov 4	Eizenman	Papoulis & Pillai Probability, RV and Stochastic Processes	Estimation of Mean, Variance, correlation with finite Observation Time. Examples: Evoked potentials. Random noise, Mean, Variance and Moments, Uniform and Gaussian noise. Signals and Noise, Random processes, Stochastic processes, Stationarity, Ergodicity, Autocorrelation, Cross correlation.
9	Nov 11	Eizenman	Papoulis & Pillai Probability, RV and Stochastic Processes	Frequency domain representation of Random Processes – Power Spectra, Periodogram, Parametric Models of PSD estimation. AR, MA and ARMA models. Examples: ECG
10	Nov 18			
11	Nov 25	Eizenman	Papoulis & Pillai	Z-transform, Digital Filters. FIR, IIR, Weiner filters, Adaptive filters, adaptive line enhancer. Examples fetal ECG.
12	Dec 2			
13	Dec 9	Eizenman	Papoulis & Pillai	Detection and estimation: Binary detection, Bayes Theorem, Minimax Test, Neyman Pearson, Receiver operating Curve. Non-parametric detection: K-nearest neighbor, Discriminant functions.
14	Dec 16			Final exam

8/ Reference Materials:

1. A.V. Oppenheim and A.S. Willsky, **Signals and Systems**, Prentice Hall, 2nd edition (1996). ISBN 0-13-814757-4
   This text is available from Amazon, and there are a few copies placed on reserve in the engineering library. The first edition of this text is organized slightly differently, but has primarily the same material.

2. A. Papoulis, S.U. Pillai, Probability, **Random Variables and Stochastic Processes,** McGrawHill, 4th Edition.

3. Leif Sornmo and Pablo Laguna, **Bioelectrical Signal Processing in Cardiac and Neurological Applications,** Elseveir, Academic Press

4. M.H. Hayes, **Digital Signal Processing**, Schaum's outlines, McGraw Hill, 2nd edition (2012). ISBN 978-0-07-163509-7

5. H. Hsu, **Signals and Systems**, Schaum's outlines, McGraw Hill, 2nd edition (2011)