MIE 1452: Signal Processing – Winter 2021

1/ Instructors:

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2/ Lecture Times: Wednesday, 1:00 – 3:00 pm (tentative)

3/ Lecture Location: TBA
(on-line course participation available)

MIE 1452: Course outline (contd.)

4/ Course Background:

The course is targeted towards senior graduate students who are collecting signals in an experimental research program. Signal Processing requires a lot of math! Particularly useful background knowledge:

- Good familiarity with complex numbers
- Some familiarity with Fourier series or Fourier transforms
- Familiarity with a mathematical package such as MATLAB
- Good comfort level with statistics

5/ Course Organization:

The course is divided into two main modules:

a) Analysis of systems (Lectures 1-6)

b) Random signals, Power Spectra, filtering and adaptive systems (Lectures 7-13)

MIE 1452: Course outline (contd.)

6/ Grading Scheme:

Assignments (Lectures 1-6) – 5%

Assignments (Lectures 7-12) – 5%

Midterm (closed book – formula sheet will be provided) – 25%

Term project – 35%

Final exam (closed book – formula sheet will be provided) – 30%

All relevant course materials will be posted on Quercus

Lecture Topics

Lecture No.	Date	Topics
1	Jan 13	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. Signal convolution. Definition of Fourier Transform.
2	Jan 20	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	Jan 27	
4	Feb 3	
5	Feb 10	Signal Modulation. Selection of signal windowing kernel. Signal scalloping. Introduction to low-pass signal filters.
6	Feb 17	Noisy signals. auto-correlation and cross-correlation functions. signal chirps. analytic signal. Applications.
7a	Feb 24	Mid –Term (first half of lecture period). It will be based on all lectures delivered by Sinclair up to this date (1 hour)
7b	Feb 24	Description of Term Projects (Second half of lecture period)

Lecture Topics (contd.)

Lecture No.	Date	Topics
8	Mar 3	Random noise, Mean, Variance and Moments, Uniform and Gaussian noise. Binary detection, Receiver operating Characteristics, Baysian classifier
9	Mar 10	Random processes, Stochastic processes, Stationarity, Ergodicity, Autocorrelation, Cross correlation. Frequency domain representation of Random Processes – Power Spectra, Periodogram, Parametric Models of PSD estimation. AR, MA and ARMA models.
10	Mar 17	
11	Mar 24	Z-transform, Digital Filters. FIR, IIR, Weiner filters, Adaptive filters, adaptive line enhancer. Examples fetal ECG.
12	Mar 31	
13	Apr 7	Kalman Filters, PCA, ICA
14	Apr 14	Final exam

General Reference Materials on Signal Processing

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 in the engineering library. The first edition of this text is organized slightly differently, but has primarily the same material.

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

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

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

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