Fundamentals of Digital Signal Processing

UC Berkeley Extension, Spring 2008

Instructor

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Time and location

Thursdays 6:30-9:30pm, April 10th through June 5th 2008. Classes are at the UCB Extension Center, Redwood City CA.

Prerequisites

Understanding of calculus and complex numbers; familiarity with computer programming; access to the Internet.

Textbook

There is no textbook. I would highly recommend these two references

1. R. G. Lyons, *Understanding Digital Signal Processing* 2nd Ed, Prentice-Hall.
2. S. W. Smith, *The Scientist and Engineer's Guide to Digital Signal Processing*, California Technical Publishing. (Download from www.dspguide.com or purchase at bookstore)

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Course Web Page

http://www.triplecorrelation.com/courses/fundsp/

Student Profile (please fill out and email to r.kakarala@ieee.org)

1. Your name and preferred email address.
2. Prior experience with DSP, if any.
3. Interests related to this course.

Recommended software

Students are strongly encouraged to purchase MATLAB Student Version, which is about $100 at UCB bookstore. You can also order online at www.mathworks.com[1]. Below are some free alternatives to MATLAB.

1. Octave for Linux and Windows. Octave uses the same syntax as MATLAB, so *in principle* all of the examples in the book should work. Download from www.octave.org.
2. Ch. This is a C interpreter, with many extras. It is free for student use. Download from www.softintegration.com
3. C/C++/FORTRAN. Use either GNU C or Borland C, both free.

Additional references

[1] The online order form asks for your student ID. Extension students can enter "1".

1. J. McClellan, R. Shafer, M. Yoder, *Signal processing first*, Pearson.
2. A. V. Oppenheim, A. S. Willsky, *Signals and systems*, Prentice-Hall.
3. K. Steiglitz, *A DSP Primer*, Addison-Wesley.cpd
4. A. V. Oppenheim, R. W. Shafer, J. R. Buck, *Discrete-time signal processing*, 2nd Ed.,
5. Sanjit K. Mitra, *Digital Signal Processing: A computer-based approach*, 2nd Ed., McGraw-Hill.

Grading

You may choose to take the course on a graded or ungraded basis. For the graded option, grades are computed as follows:

20% Homework: 4 assignments.

40% Computer project.

40% Take-home final exam.

Completion of the assignments requires approximately 30 hours of work over the term, or 3 hours a week.

If you prefer to take the course on an ungraded basis, there are two options:

1. "Pass/No Pass" basis, which requires that you complete at least 50% of the coursework to pass;
2. "No Credit" basis, which requires only attendance.

You have until the last class to decide.

Syllabus

1. Fundamentals.
   (a) Complex numbers.
   (b) Statistics and probability.
   (c) Arithmetic of sinusoids
2. Spectrum estimation
   (a) The discrete Fourier transform
   (b) Interpreting the DFT
   (c) The fast Fourier transform
   (d) Spectrogram
3. Frequency domain analysis
   (a) Fourier series
   (b) Fourer transform
4. Sampling and reconstruction
   (a) Nyquist and Shannon
   (b) Aliasing
   (c) Reconstruction
5. Discrete-time systems
   (a) Linearity and time-invariance

(b) Impulse response

(c) Convolution

(d) FIR and IIR filters

(e) Filter banks.

6. Mathematical analysis of filters

   (a) Frequency response

      i. Sinusoidal response

      ii. Magnitude and phase of frequency response

      iii. Symmetries

      iv. Lowpass, Highpass, and Bandpass filters

   (b) Z-transform

      i. Convergence

      ii. Poles and Zeros

      iii. Stability

7. Filter design

   (a) Filter specifications

   (b) FIR filter design by window method

   (c) IIR filter design

   (d) Implementation methods

8. Additional topics

   (a) Use of numerical packages such as MATLAB

   (b) Compression: JPEG, MPEG

   (c) Communications: Equalization, OFDM modulation