

Information Sheet

- Instructor : Prof. Essam A. Marouf
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Office Hours : M&W 2:15-4:15 pm
- Format : Lectures M&W 4:30-6:45 pm, CL 117
+ Computer simulations using Matlab and the DSP Toolbox.
- Prerequisite : Familiarity with digital filters, matrix algebra, and random signal analysis;
EE153/253, EE102/250, or equivalent.
- Description : (see also the handout Tentative Topics Covered). Introduction to multirate signal processing and filter-banks. Random signal models. Estimation of mean and autocorrelation function. Classical power spectrum estimation. FIR & IIR Optimal (Wiener) filtering. Linear prediction. The Levinson-Durbin algorithm and lattice filter realizations. Adaptive filtering using the LMS and RLS algorithms and adaptive filters applications.
- Texts : 1- Statistical Digital Signal Processing and Modeling, M. Hayes, Wiley, 1996.
2- Adaptive Filtering Primer with Matlab, A. Poularikas and Z. Ramadan, CRC 2006.
3- Lecture Notes and Class Handouts
4- The Student Version of Matlab (Release 14) and the Signal Processing Toolbox, The Mathworks, 2006 (see next page).
- References :
1- *Statistical and Adaptive Signal Processing*, Manolakis, Ingle, and Kogon, McGraw-Hill, 2000.
2- *Adaptive Filter Theory*, 4th Ed., S. Haykin, Prentice-Hall, 2001.
3- *Adaptive Signal Processing*, Widrow and Stearns, Prentice-Hall, 1985
4- *Adaptive Filters: Theory and Applications*, B. Farhang-Boroujeny, Wiley, 1998
5- *Adaptive Filtering: Algorithms and Practical Implementation*, 2nd Ed., P. S. R. Diniz, Kluwer, 2002.
6- *Optimal and Adaptive Signal Processing*, P. Clarkson, CRC, 1993.
7- *A Course in Digital Signal Processing*, B. Porat, Wiley, 1997.
8- *Digital Signal Processing*, 3rd Edition, J. Proakis and D. Manolakis. Prentice-Hall, 1996.
- Grading:
- | | |
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| Homework | 4% |
| Midterm Exam #1 (Monday March 7) | 32% |
| Midterm Exam #2 (Monday April 18) | 32% |
| Optional Term Project (replaces the worst midterm) | 32% |
| Final Exam (Monday May 23, 7:45-10:00 pm) | 32% |

Exams & Term Project:

All exams are in-class, open book and notes. No make up exams are given. A term project that deals with an in depth study of a relevant application, including either computer simulations using Matlab/C/C++ or DSP hardware implementation, is optional. The project grade replaces the worst of the two midterms. More details regarding topics and the scope of the term project will be handed out in class at a later time.

Homework:

Homework is crucial for the understanding of the course material. Homework will be assigned regularly. If a qualified grader can be found, a homework part will be fully graded and the other part will be checked for completeness. Solutions for the analytical part of the problems will be provided. Part of the homework will require using Matlab. Please note that the 4% for the homework can move your grade across grade boundaries.

Matlab:

Matlab is used as the computational platform for class examples and homework problems. Matlab and many of its Toolboxes are available on the PCs in ENG 387. The lab operates on an open door policy. Check availability times posted on the lab door. You may also want to consider purchasing the Student Version of Matlab (~\$100) to use it at home. This is perhaps the most convenient way to do the computational assignments and Project at your time convenience. You will also need to purchase the Signal Processing Toolbox (~\$30). Check the web site <http://www.mathworks.com/academia/> regarding how to order the DSP Toolbox (it's a download). You may order the Matlab Student Version (Release 14) on the web, or may purchase it directly from the Spartan Bookstore (check the shelf of EE254).

Matlab m-files referenced in all textbooks can be downloaded from the websites below:

- 1) Hayes: http://users.ece.gatech.edu/~mhayes/stat_dsp/.
- 2) Mitra 3rd ed: <http://highered.mcgraw-hill.com/sites/0072865466/> (Chs. 13 &14)
- 3) P&R: http://www.crcpress.com/e_products/downloads/default.asp

If you are not familiar with Matlab (you should be if you already took EE253), you should go through the tutorials in the Student Version manual IMMEDIATELY! A web- based introduction is at <http://www.mathworks.com/access/helpdesk/help/techdoc/matlab.shtml>. Electronic versions of all Matlab+Toolboxes manuals may be accessed at the same web site. Matlab has a good help facility that you should invoke to learn more about specific commands or functions.

EE254 Website: There is a website for this class hosted by WebCT. Please sign for an account The URL is <http://sjsu.webct.com/>. All handouts (except Lecture Notes) will be posted there.

IMPORTANT NOTE: POSSIBLE FRIDAY LECTURES

In addition to my teaching duties, I am also involved in research projects related to planetary exploration by unmanned spacecraft. To be able to attend related technical meetings during the semester, some rescheduling of class time will be necessary. During one or more weeks of the semester the class may be taught M & F, W & F, or M, W, & F to compensate for any sessions missed during travel. Please make sure that you are available to attend the lecture on Friday (4:30-5:45 pm), in addition to the regular times on M & W. Any Friday lectures will be announced in class ahead of time.

TENTATIVE COURSE OUTLINE & READING ASSIGNMENTS

Please read Hayes Sec. 2.2 and P&R Ch. 2 to review some basic DSP material (covered in EE253), and Hayes Sec. 2.3 and P&R Appendix to review important linear algebra concepts.

MULTIRATE SIGNAL PROCESSING

	Mitra (Handout)
Decimation and interpolation; sample rate conversion	10.1-10.3
Polyphase decomposition	10.4
DFT Filter banks	10.6, 10.7
Perfect-reconstruction (PR) two-channel filter banks	10.8, 10.9
Tree-structured, multi-channel, PR filter banks	10.12
Applications: time-division and frequency-division multiplexing (TDM & FDM), carrierless (DMT) modulation, subband coding of speech/audio/image signals	11.8-11.11

CHARACTERIZATION OF NOISY SIGNALS & SPECTRUM ESTIMATION

	Hayes	P&R
Correlation, power spectra, and filtering of noisy signals (review)	3.3-3.5	3.1, 3.3-3.6
Filtered white-noise signal models (MA, AR, ARMA models)	3.6	3.7
Estimation of mean and correlation function		3.2
Classical spectrum estimation (Bartlett, Welch, Blackman-Tukey, ...)	8.2	3.8
Parametric spectrum estimation (AR, MA, ARMA)	8.4	3.9
Applications: Detection and parameter estimation of noisy sinusoids	8.2	

OPTIMAL FILTERING, LINEAR PREDICTION, & LPC CODING OF SPEECH

	Hayes	P&R
Optimal (Wiener) FIR/IIR Filtering	7.2, 7.3	4.1-4.3
Applications: signal filtering, system identification, noise cancellation, channel equalization, linear prediction	7.2	4.4
Forward/Backward linear prediction	5.2.1-5.2.5	Handout
Levinson-Durbin Algorithm.	5.2.1-5.2.5	(Haykin)
Lattice Realizations	6.2, 6.4, 7.2.4	
Applications: LPC coding of speech; speech synthesis.		

FIR ADAPTIVE FILTERING

	Hayes	P&R
The mean-square error performance surface	9.1, 9.2	5.1-5.2
Steepest-descent search algorithm	9.2.1	6.1-6.2
Adaptive LMS algorithm	9.2	7.1-7.3
Performance measures	9.2.3	7.4
Variants of LMS Algorithm	9.2.6	8.1-8.8
Gradient Adaptive Lattice (GAL) algorithm	9.2.7, 9.2.8	
Recursive Least-Square (RLS) algorithm	9.4	9.1-9.7
Applications: linear prediction echo cancellation, interference suppression, system modeling, line enhancement, channel equalization, ...	9.2.5, 9.2.9	7.3