EE253, Spring 2007 Prof. Essam Marouf
Digital Signal Processing I

**Information Sheet**

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| Instructor: | Prof. Essam A. Marouf |
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| Office Hours: | M & W 2:15 to 4:15 pm |

Format: Lectures M&W 6:00-7:15 pm + Computer simulations using Matlab

Prerequisites: Basic knowledge of signals, systems, and transforms (EE112/210 or equiv.)

Corequisite : EE210 (graduate Linear Systems). You may want to consider completing EE210 first for a good foundation in Signals and Systems.

Description: Time and frequency analysis of discrete-time signals and systems. A/D & D/A conversion. The DFT and its properties. Spectral analysis of deterministic signals. FFT implementation of the DFT. Fast convolution and correlation. Analysis, design, and implementation of FIR and IIR digital filters. Quantization and round-off effects. Introduction to multirate signal processing (time permitting).

Texts:

1. *Discrete-Time Signal Processing*, Second Edition. A. V. Oppenheim & R.W. Schafer (with J. Buck), Prentice Hall, 1999. Referred to as O&S in the class notes. This is the main text for the course (required).

2. Fundamentals of *Digital Signal Processing Using Matlab*, R. Schilling and S. Harris, Thomson 2005. A relatively new book covering theory and includes a Matlab toolbox and many Matlab examples and exercises (required).

3. *Digital Signal Processing*, M H. Hayes, Schaum's Outline Series, McGraw-Hill, 1999. A moderately priced good source of additional solved and unsolved problems (recommended).

4. The Student Version of Matlab (Release 14) and the Signal Processing Toolbox, The Mathworks, 2004. Matlab is the computational tool for this course (recommended; please see next page).

Other References:

1. *Digital Signal Processing: A Computer-Based Approach*, 2nd Ed., S. K. Mitra, McGraw-Hill, 2001. Bundled with *Digital Signal Processing Laboratory Using Matlab*. A previous textbook for EE253.

2. *Digital Signal Processing: Principles, Algorithms, and Applications*, R. A. Proakis and D. G. Manolakis, 4th Ed., Prentice-Hall, 2006,

Grading:

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| Homework | 5% |
| Midterm Exam #1 (Day & Time TBD) | 30% |
| Midterm Exam #2 (Day & Time TBD) | 30% |
| Optional Term Project (replaces the worst midterm) | 30% |
| Final Exam (See Final Exams Time schedule) | 35% |

**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 computer simulations or DSP board implementation, is optional. The optional project grade could replace 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 critical for understanding the course material. Homework will be assigned regularly and, if a grader is found, will be partially graded. Solutions will be provided (except for some Matab problems). Please try to solve the homework problems on your own. This is critical if you are to understand the course material and to do well in the exams. Part of the homework will require using Matlab. The 5% homework grade can move one across grade boundaries.

**Matlab:**
Matlab is used as the computational platform for class examples and some 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 want to consider purchasing the Student Version of Matlab (Release 14) to use at home (~$100). This is a convenient way to do the computational assignments and Project at your own convenience. It's available at the Spartan Bookstore (check the shelf of EE253, or check the Software shelf of the Bookstore Computers section). You can also order it directly from the Mathworks website. You will also need to purchase the Signal Processing Toolbox (~$30) through an electronic download from the Mathworks website:
http://www.mathworks.com/products/education/student_version/sc/index.shtml.

If you are not familiar with Matlab, A Mathworks introduction can be found at http://www.mathworks.com/access/helpdesk/help/techdoc/learn_matlab/learn_matlab.html, as well as in the Student Version Manual. Several good Matlab tutorials are also available on various websites. Google 'Matlab tutorial.' Electronic versions (html and pdf) of Matlab and all Toolboxes manuals can be accessed at the Mathworks website above, and on the Student Version CD. Matlab has very good help facility that you should invoke to learn more about specific commands and functions.

*YOU DO NEED TO LEARN AND USE MATLAB TO GET THE BEST OUT OF THIS COURSE. MATLAB-BASED PROBLEMS MAY BE INCLUDED IN ALL EXAMS.*

**Textbook Website:** The Schilling & Harris textbook includes a CD in the back of the book. For possible updates, please check the book website http://people.clarkson.edu/~schillin/fdsp/**.**

**EE253 Website**: A website for this class hosted by WEBCT is being established at this time. The URL will be provided in class.

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**IMPORTANT NOTE: POSSIBLE FRIDAY LECTURES**
In addition to my teaching duties, I am also involved in research projects related to radio exploration of the solar system using robot 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 (6:00-7:15 pm), in addition to the regular times on M & W. Any Friday lectures will be announced in class ahead of time.

| **Tentative Topics Covered & Reading Assignments** | **Lecture Notes** | **O&S Sec.** | **S&H Ch.** | **Hayes Ch.** |
|---|---|---|---|---|
| Time and frequency representation of discrete-time signals and systems | 1, 2 | 2.0-2.10 | 1.1-1.2 | 1, 2 |
| A/D & D/A conversion; sampling theorem | 3 | 4.0-4.3<br>4.8-4.9 | 1.3-1.6 | 3.1-3.4 |
| DFS, DTFT, and DFT properties of the DFT | 4, 5 | 8.1-8.6 | 3.1-3.4 | 6.1-6.5 |
| Fast convolution & correlation | 5 | 8.7 | 4 | 6.6 |
| DFT computation using the FFT; | 6 | 9.0-9.5 | 3.5 | 7.2 |
| Spectra of sinusoids; resolution and leakage | 7 | 10.0-10.2<br>7.2.1-7.2.2 | 3.6-3.9 | |
| Time-varying spectra; the short time Fourier transform (STFT) | 8 | 10.3-10.5 | 3.10 | |
| Signals & systems in the complex frequency domain (Z-transform) | 9 | 3.0-3.4 | 2.1-2.5 | 4.1-4.4 |
| Frequency response; system function; stability of discrete time systems | 9, 10 | 5.0-5.4 | 2.6-2.9 | 5.2 |
| Example discrete-time systems; LP, HP, BP, BS, notch, comb, allpass | 11A, 11B | 5.5-5.6 | 8.1-8.3<br>5.4 | 5.4, 5.5 |
| Canonical realizations | 13 | 6.0-6.5 | 5.1-5.2<br>5.5-5.6 | 8.1-8.4 |
| Linear Phase FIR filters | 12 | 5.7 | 5.3 | 5.3 |
| FIR filter design: window method; frequency sampling method | 16, 17 | 7.2-7.3 | 6.1-6.3 | 9.3.1, 9.3.2 |
| FIR filter design: Optimum (Parks-McClellan) method | 18 | 7.4-7.5 | 6.5-6.6 | 9.3.3 |
| IIR filter design; bilinear transformation | 14 | 7.0-7.1 | 8.1, 8.3, 8.5 | 9.2, 9.4 |
| IIR filter design; Butterworth , Chebyshev and elliptic designs | 14, 15 | 7.1<br>App. B | 8.4, 8.6 | 9.4 |
| Digital filter implementation, Quantization & round-off effects | 19, 20 | 6.7-6.9 | 5.7-5.8 | 8.6 |