COURSE SYLLABUS: EE483 - INTRODUCTION TO DIGITAL SIGNAL PROCESSING

Instructor: Dr. Edgar Satorius

1. Schedule and Introduction

This class meets 6:00 PM - 9:10 PM every Tuesday evening in OHE 122 beginning May 26, 2009 and ending on August 11, 2009. The TA is Rajit Chatterjea and the grader is Ajay Kashyap. There will also be a discussion section for this class meeting every Thursday evening in OHE 136 from 5:00 – 5:50 PM beginning May 28, 2009. The discussion section will be conducted by the TA.

The sections given below are an outline of the topics I hope to cover in this course. Section 4 is mainly a review of material you should have covered in a Linear Systems course. If you are not too familiar with this material or need to refresh your memory, I suggest you use the "Signals and Systems" book by Oppenheim and Wilsky referenced below or perhaps the “Signals and Systems Made Ridiculously Simple” book by Karu also referenced below (actually I have not read this book but its title sounds interesting!).

Policy on class attendance for on-campus students: There is no requirement to attend the class in the studio (though I appreciate in-studio attendance as it can get lonely !!!!). The only exception is during the August 4 class when we are doing course evaluations – please plan to attend this class.

2. Grading and Computers

Midterm:	30%
Final:	30%
Homeworks:	10%
Two Matlab computer projects:	30% (15% each)

Throughout the semester I will assign 5-6 homework sets plus two Matlab computer projects. The homework sets will help prepare you for the midterm and final exams. The Matlab projects will help you learn the material by conducting practical computer experiments on real world problems. If you do well on the homeworks and the projects, then you will be able to perform well in the class. Do the homeworks on your own (although I encourage you to discuss the problems with your friends). Likewise with the Matlab assignments: please discuss them, but write them yourself. The midterm will include all material covered up to the midterm and the final will cover the remainder of the course. Both exams will be closed book.

Policy on late assignment submittals: I will allow late submittals **provided you let me know in advance via e-mail**. However, once the solutions are posted (typically about a week after the assignments are due), no submittals will be accepted or graded. **One other important note regarding assignment submittals for on-campus students**: Do not interrupt the class to submit an assignment (I will not accept or grade assignments submitted during the class). You must submit your assignment either before or after class or during the break.

3. Office Hours

My office hours are 5:00-6:00 Tuesdays in EEB 104. TV students may call me during this time (213 740 6433), or arrange an appointment for Tuesday evenings. I strongly encourage you to make use of this time to discuss problems with the course material or any related aspects of digital signal processing which interest you. If you can't reach me otherwise, my e-mail address is: **Edgar.H.Satorius@jpl.nasa.gov**.

Questions related to the homework, projects, Matlab, etc. should initially be addressed to either the TA or grader. The TA's e-mail address is: **rchatter@usc.edu**. The TA's office hour is Friday 3-5 PM EEB 106 (you can reach the TA during his office hours at 213 740 3487). The grader's e-mail address is: **aakashya@usc.edu**. The grader's office hour is Monday 4-6 PM EEB 106 (you can reach the grader during his office hours at 213 740 3487). Please make use of our TA and grader – remember: they're located on-campus and I'm not !

COURSE OUTLINE:

4. Introduction to discrete linear systems (Class 1)
[Mitra, §§2.1-2.7]

[1] Discrete time signals.
[2] Special sequences.
[3] Shift invariance.
[4] Stability and causality.
[5] Impulse response.
[6] Difference equations.

5. Discrete-Time Fourier Transform and Linear Time Invariant Systems (Class 1-2)
[Mitra, §§3.1-3.9]

[1] Transform definitions.
[2] Theorems.
[3] Frequency response of linear time invariant systems.
[4] Phase and group delays.
[5] Matlab computations.

6. The Z transform (Class 2)
[Mitra, §§6.1-6.7]

[1] Z-transforms by summation of left, right, and two-sided sequences.
[2] Regions of convergence and Z-transform properties.
[3] Inverse Z-transform.

7. Properties of digital filters (Class 3)
[Mitra, §§8.1-8.12]

[1] Averaging filter.
[2] Recursive smoother.
[3] First-order notch filter.
[4] Second-order unity gain resonator.
[5] All-pass filters.
[6] Comb filters.
[7] Equalization filters.
[8] Group delay, linear phase, all-pass, minimum phase

8. Fourier transforms, sampling – Part I (Class 4-5)
[Mitra, §§4.1-4.6, 13.1]

[1] Fourier transform review.
[2] Sampling continuous-time signals: the sampling theorem.
[3] Aliasing.
[4] Re-sampling digital signals.

[5] Midterm review.

9. Midterm, Class 6: June 30, 2009

8. Fourier transforms, sampling – Part II (Class 7)
[Mitra, §§4.7-4.11, 13.2-13.6]

[1] A/D conversion and quantization
[2] D/A conversion
[3] Polyphase decomposition
[4] Polyphase DFT filterbanks
[5] Bandpass sampling

10. The discrete Fourier transform (Class 8-9)
[Mitra, §§5.1-5.9, 15.1, 15.2]

[1] Definition of DFT and relation to Z-transform.
[2] Properties of the DFT.
[3] Linear and periodic convolution using the DFT.
[4] Zero padding, spectral leakage, resolution and windowing in the DFT.

11. The fast Fourier transform (Class 9)
[Mitra, §§11.1, 11.3]

[1] Decimation in time FFT.
[2] Decimation in frequency FFT.

12. Digital filter design

12.1. Finite impulse response (FIR) filters (Class 10)
[Mitra, §§10.1, 10.2, 10.5]

[1] Window design techniques.
[2] Kaiser window design technique.
[3] Equiripple approximations.

12.2. Infinite impulse response (IIR) filters (Class 10-11)
[Mitra, §§9.1-9.6]

[1] Bilinear transform method.
[2] Examples of bilinear transform method.

13. Structures and properties of FIR and IIR filters and review (Class 11)
[Mitra, §§8.1-8.9]

[1] IIR - Direct, parallel and cascaded realizations.
[2] FIR – Direct and cascaded realizations.

[3] Coefficient quantization effects in digital filters
[4] Final review.

14. Final: 6:30-8:30 PM, August 11, 2009

15. References

15.1. Required Texts/Notes

[1] Digital Signal Processing: A Computer-Based Approach, S. K. Mitra, McGraw-Hill, Third edition, 2006.

[2] The Student Edition of MATLAB, Prentice-Hall, New Jersey.

[3] Supplementary class notes, available over the USC Distance Education Network.

15.2. Recommended Reading

[1] Discrete-Time Signal Processing, A. Oppenheim and R. Schafer, Prentice Hall, Second edition, 1999.

[2] MATLAB Reference Guide: High-Performance Numeric Computation and Visualization Software, The MathWorks, Inc., South Natick, MA, 1984-92.

[3] Computer-Based Exercises for Signal Processing Using MATLAB 5, J. McClellan (Ed.), Prentice Hall, 1997.

[4] Digital Signal Processing Using MATLAB (r), V. Ingle, J. Proakis, Brooks/Cole Pub. Co., 1999.

[5] A Course in Digital Signal Processing, B. Porat, J. Wiley and Sons, 1996.

[6] Understanding Digital Signal Processing, R. Lyons, Prentice-Hall, 1996.

[7] Digital Signal Processing: Principles, Algorithms and Applications, J. Proakis, D. Manolakis, Prentice-Hall, 1995.

15.3. Background Material

[1] Signals and Systems Made Ridiculously Simple, Z. Karu, ZiZi Pr Pub., 1995.

[2] Signals and Systems, Oppenheim, Wilsky, et. al., Prentice Hall, 1996.

[3] Schaum's Outline of Digital Signal Processing, M. Hays, McGraw-Hill, 1998.

[4] Linear Algebra and Its Applications, G. Strang, International Thomson Publishing, 1988.

[5] Orthogonal Transforms for Digital Signal Processing, N. Ahmed, Springer-Verlag, 1975.