ESE 347. Digital Signal Processing: Implementation

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Location: SOCBEHAV SCI N102 (M, W, 5.30-6:50 PM) **Labs:** Light Eng. Lab., Room 179 (M, 7.00-10.00 PM).

Office hours: Suffolk Hall (South Campus), Room 121 (TU, TH, 12.00-1.30 PM)

Course Overview: This is a course in implementation techniques for Digital Signal Processing, based on the Texas Instruments TMS320F28335 DSP microcontroller.

The course consists of two main parts: lectures and laboratory work. The lectures will cover the basic architecture and features of the TMS320F2833x family of floating-point DSP microcontrollers, an overview of the development tools for this family, and the basic theory of simple DSP algorithms: FIR and IIR filtering, modulation, FFT, and (possibly) adaptive filtering. The laboratory work will consist of implementing and testing these algorithms on the TMS320F28335, and comparing their performance to that predicted by the theory. Apart from the beginning labs, the implementation will be in real time, with analog input and analog output, and will be done mostly on the Texas Instruments Peripheral Explorer Board".

We will cover the following topics in some detail:

1. Basic DSP concepts; sampling and reconstruction of signals.
2. Architecture and features of the TMS320F28335 and the Peripheral Explorer Board.
3. Program Development Tools - Code Composer Studio™.
4. Convolution and FIR filtering.
5. Interfacing to a two-channel A/D and D/A converter.
6. FIR filter design and implementation.
7. Signal flow-graphs and digital filter structures.
8. IIR filter design and implementation.
9. Pulse-Width Modulation.
10. Quadrature Encoder Positioning.
11. Discrete and Fast Fourier Transforms (DFT and FFT).

Learning Objectives: At the end of this course, students should know basic techniques and tools of digital signal processing:

1. Detailed knowledge of the architecture of a modern DSP chip.
2. Expertise with a real-time hardware development tool (evaluation module or in-circuit emulator) for the same chip.
3. Expertise with a full set of software tools (compiler, linker, debugger, and integrated design environment) for the real-time development hardware.
4. Understanding of peripheral interface techniques in a high-level language.
5. Ability to implement the basic DSP algorithms (FIR filters, IIR filters, oscillators, FFT) in real time.

Text: There will be no required textbook for this course. Instead, we will use the documentation available on the Texas Instruments website. The required theory will be covered in class. The class assignments, materials, and handouts will be posted on Blackboard. The above chapter references are to the TI "C2000 Teaching ROMs", which can be downloaded from Texas Instruments website. We will also use the following references:

- TMS320f28335 Data Sheet: http://www.ti.com/lit/ds/symlink/tms320f28335.pdf
- TMS320C28x CPU and Instruction Set Reference Guide: http://www.ti.com/lit/ug/spru430f/spru430f.pdf
- TMS320C28x Floating Point Unit and Instruction Set Reference Guide: http://www.ti.com/lit/ug/sprueo2a/sprueo2a.pdf
- TMS320C28x Optimizing C/C++ Compiler User's Guide: http://www.ti.com/lit/ug/spru514l/spru514l.pdf
- TMS320C28x Assembly Language Tools User's Guide: http://www.ti.com/lit/ug/spru513l/spru513l.pdf
- Stereo Audio Codec TLV320AIC23B: http://www.ti.com/lit/ds/symlink/tlv320aic23b.pdf

All necessary theory on Digital Signal Processing will be covered in class. Any book on Digital Signal Processing can be used for reference. The book "Discrete-Time Signal Processing" by A.V. Oppenheim and R.W. Schafer (2nd or 3rd edition) is a good choice. The book 'Introduction to Signal Processing' by S.J. Orfanidis may be downloaded for free from the author's website http://www.ece.rutgers.edu/~orfanidi/intro2sp as PDF file.

Software: Code Composer Studio™ will be used in the lab; access to MATLAB is recommended.

Examinations: Midterm test and final examination. If the final is missed, a makeup will be allowed only for the most serious reasons; written evidence of the reasons for missing the final will be required.

Grading: The labs will count for 40% of the overall grade, the midterm and final will each count for 30%. The lab reports must be submitted electronically as PDF files. The reports must be properly formatted and look presentable. The lab will not be graded until the acceptable lab report is submitted. The portfolio is not required.

If you have any conditions, such as physical or mental disability, which will make it difficult for you to carry out the work as outlined above, please notify me in the first two weeks so that appropriate arrangements could be made.