Course Number and Title: EEL 4xxx – DSP/FPGA Laboratory

Term and Meeting Info: Fall 2013 - Lecture: M 11:50-1:40 pm in ENB 237
Lab Session 1: M 2:00-5:50 pm in ENB 237 (Limited to 10 students)

Instructor Info: Dr. Ravi Sankar, Professor of Electrical Engineering
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Office Hours: Generally open door policy;
Specific Hours: TBA (ENB 373); MW 5:00-6:00 pm (on-line email and telephone). You can also contact me by email/voice mail any time or by appointment
Teaching (LAB) Assistant(s): TBA
Office Location: TBA; Office Phone: TBA; E-mail: TBA
Office Hours: TBA

Catalog Description: Design of real-time systems from algorithm to hardware using DSP, FPGA and hybrid DSP/FPGA rapid prototyping platforms. The course has both lecture and laboratory components. The lectures explain the DSP and communication theories in a practical way with MATLAB examples and computer demonstrations. The lab exercises include source/channel coding, modulation, filtering, and spectral analysis (FFT), followed by projects on wireless and digital communications, adaptive filters, and speech processing. (3 credits)

Semesters Offered: Fall

Course Prerequisites: Linear Systems Analysis (EEL 4102)
Prerequisites by Topic: Linear systems theory, Basics of digital signal processing and digital communication systems, Fundamentals of logic design and microprocessors.

Course Corequisites: None

Courses that require this as a direct prerequisite: None

Level: UG (Senior) Credits: 3 Class Time: 1 hr and 45 min lecture and four hours laboratory per week

Text Info:
  A copy of the book is available from Pro-Copy, 5209 E. Fowler Avenue, Tampa, (Tel: 988-5900)
  You can also download a softcopy from the course website.

- DSP/FPGA Laboratory Course Handouts, R. Sankar, USF, 2011.

References (supplemental reading):
Course Objectives/Outcomes:
Familiarize the students with the development of real-time digital signal processing systems from algorithms to hardware using DSP, FPGA and hybrid DSP/FPGA rapid prototyping platforms. Several structured laboratory exercises will introduce the students to fundamental theory, design of algorithms using software such as MATLAB and implementation using hardware platforms. This is followed by detailed projects on wireless and digital communications, adaptive filters, speech processing, etc.

- Students learn the basic theory of digital signal processing (DSP) and communications. (ABET Criteria: (a) and (l))
- Students learn the process of developing of DSP systems from algorithms to real-time implementation (connect theory with practice) (ABET Criteria: (a), (c), and (e))
- Students learn fundamental theory, design of algorithms, and implementation by performing as a team several structured laboratory experiments using hardware platforms and software such as MATLAB/Simulink, Code Composer Studio and Real-Time Workshop (ABET Criteria: (b), (d), (e), and (k))
- Students conduct design project using state of the art DSP/FPGA platforms. Effectively communicate by writing technical report and delivering oral and poster presentations (ABET Criteria: (a), (c), (d), (e), (f), (g), (k), and (m))

Topics:
1. Fundamental Theory
2. Design (Simulation) using MATLAB/ Simulink and C
3. Implementation using DSP, FPGA and Hybrid DSP/FPGA platforms

Theory (No. of Lectures)
- Lab overview and course goals (1)
- DSP Overview: Sampling Theory, Analog-to-Digital Converter (ADC), Digital-to-Analog Converter (DAC), and Quantization (1)
- Decimation, Interpolation, Convolution, Windows, Simple Moving Average, Fourier Transform (DFT/FFT), Spectral Analysis (1)
  - Digital Filters - FIR and IIR Filters (1)
- Introduction to DSP architectures, Fixed and Floating Point Representations and Programming (2)
- Digital Communications Overview: Channel Coding (1)
- Modulation: Off-Keying (OOK), BPSK/QPSK, QAM modulation (1)
- Voice/Data Scrambling and Descrambling (1)
- Adaptive Filtering: Echo/Noise Cancellation, Least Mean Square (LMS) algorithm (1)
- Alternate Platforms: FPGA and hybrid DSP/FPGA design (1)
- Introduction to Software Defined Radio (1)
- Advanced Topics in Wireless Communications (Channel coding/decoding, Equalization, Simple Detection Algorithm, OFDM) and Speech Processing (Prediction Algorithms, Speech Classification, Coding and Recognition) (2)
Lab (No. of Weeks)
- Introduction to DSP Platform, hardware and software tools (1)
- Software Tutorials (Matlab/Simulink, C, Code Composer Studio) (1)
- Source encoder/decoder, echo generation (1)
- Filtering, Channel coding and Modulation (3)
- Voice/Data Scrambling-Desrambling (2)
- Echo/Noise/Interference Cancellation – Adaptive Systems (2)
- Introduction to FPGA and Hybrid DSP/FPGA Platforms (1)
- Project (3)

Lab Procedures
- **Pre-lab Assignment:** Performing some initial simulations using MATLAB code and/or C (Often codes will be provided and students will be asked to modify and use it. Students are encouraged to develop their own codes)
- **Lab:** Implementing the experiments using MATLAB/Simulink and/or C and downloading into the hardware.
- **Post-lab Assignment:** Preparing a brief report and answering a few given questions related to the experiment

Grading Policy:
**Assessment** is based on pre-lab assignments and post-lab reports for basic and advanced exercises, final project (report and oral poster presentation), and exam.

Grades will be decided based on
- Basic Lab Exercises (4) – 50 %
- Advanced Lab Exercise (1) – 25 %
- Project – 25 %

Specialization: This is an elective course for undergraduate students (senior EE major) but students from other departments like Computer Engineering can also benefit from it. This is a dual level course designed for both senior undergraduate students as well as for graduate students (a recommended core course for students in the communications and signal processing track).

Professional Component: Engineering Science - 30% Engineering Design – 70%

Additional Course Features:
MATLAB software is used to enhance the students' understanding of the course lectures. A variety of applications are demonstrated in class using software tools. There are a number of exercises that the students are required to investigate, design and conduct the experiment and report. Help sessions by the instructor and TA other than the usual office hours are utilized.

Blackboard online website (password protected) will serve as the information repository and exchange for the course. In there, the course syllabus, course calendar, assignments, announcements,
and student performance (grades) will be posted and regularly updated. It also includes other tools such as bulletin board and virtual classroom for sharing information, discussion and extended virtual office hours.

Additional Course Info (Academic Policies):

Academic Dishonesty Policy: Students are reminded that University policies pertaining to academic dishonesty commonly found in both UG and G catalogs will be applied in this course. Any form of cheating on exams or plagiarism on assigned homework and projects will result in an FF grade and further suspension or expulsion from the University with NO warnings given. Receiving or providing help on exams, assignments and project; Sharing of program codes and results, and not turning in individual work are all forms of cheating; Submissions that are "identical" in any way are clear evidence of cheating. Copying materials from textbooks and papers without properly referencing them or not giving due credit are forms of plagiarism. It is the student's responsibility to review and understand USF and EE Department policies and procedures on Academic Conduct, Dishonesty, and Disruption.

Attendance Policy: Students who anticipate the necessity of being absent from class due to the observation of a major religious observance must provide notice of the date(s) to the instructor, in writing, by the second class meeting.

Copyright Policy: Students are not permitted to sell, redistribute, or publish notes provided by the instructor, including materials posted on blackboard. Audio and/or video recording for class lectures is not permitted without the express permission of the instructor.

Relation of Course to EE Dept. Program Objectives and Outcomes:

a. An ability to apply knowledge of basic math, science and engineering.
b. An ability to design and conduct experiments, as well as analyze and interpret data.
c. An ability to design systems to meet desired needs.
d. An ability to function on multi-disciplinary teams.
e. An ability to identify, formulate and solve engineering problems.
f. An understanding of professional and ethical responsibility.
g. An ability to communicate effectively.
h. An ability to use techniques, skills and modern engineering tools (MATLAB) necessary for engineering practice.
i. Knowledge of probability, statistics and advanced mathematics.
j. Knowledge of basic and engineering science necessary to analyze and design complex electrical/electronic hardware/software devices and systems.

Standard Syllabus Prepared by: R. Sankar