

Syllabus

EC En 487

Digital Signal Processing and Real-Time DSP Laboratory

Winter, 2010

Organization

Professor: Brian Jeffs,
457 CB, phone: 422-3062, email: bjeffs@ee.byu.edu

Office Hours: Mon. and Wed., 10:00-11:00 a.m. & 3:00-5:00 p.m.

TA: Joshua Wilson email: Josh_Wilson_ee@yahoo.com

Office Hours in 425 CB: See class web page

Required Textbooks:

Lecture:

Discrete Time Signal Processing, Third Edition

A.V. Oppenheim and R.W. Schaffer

Laboratory:

A bound, hard cover, grid ruled laboratory notebook. Must have at least 70 blank pages (35 sheets).

Meeting Schedule:

Lecture All Sections, MWF 2:00 p.m., 392 CB

Laboratory Introductory Lectures (required attendance)

Both sections 1 and 2, only on the following dates:

Tues. Jan. 12, Tues. Feb 2, Thur. Feb 25, and Thur. Mar. 18

DSP Laboratory (required attendance, closed lab)

Weekly beginning Jan. 12

Section 1, Tues. 3:00-6:00 p.m., 490 CB

Section 2, Thurs. 3:00-6:00 p.m., 490 CB

Web Page: <http://www.et.byu.edu/groups/ece487web/>

ABET Accreditation Competencies

As part of degree program accreditation requirements, the desired competencies which will be assessed for students in this course are as follows:

1. Application of integral calculus, discrete math, complex variables, and transform theory to discrete-time signal processing.
2. Completion of real-time DSP design projects, including discrete-time filters, spectrum analyzer, adaptive filter, etc
3. Ability to use basic DSP functions and algorithms (i.e. FIR filters, IIR filters, polyphase systems, windows, FFTs, etc.) to formulate and solve engineering problems.
4. Ability to use MATLAB, C, and Code Composer Studio as tools to design, implement, and debug DSP functions.

General Comments

Welcome to Digital Signal Processing! This course is a natural follow-on for the discrete-time systems material in ECEN 380. Since digital signal processing is used in an increasing range of applications, the material presented in this course has become more important for B.S. graduates, and is becoming more common at the undergraduate level in universities across the country. This introductory course will be useful to students planning careers in digital signal processing (including audio, RADAR, and SONAR signal processing), communications (satellite, wireless, modem, sensor array processing, etc.), digital image processing, digital control, detection and estimation, and many other fields. We are also excited to include an integrated companion laboratory where you will learn how to implement real-time DSP applications by programming a Texas Instruments DSP processor.

Course Policies

1. GRADING

	<u>% of Grade</u>
Midterm 1 (2.5 hour, testing center, Feb. 19-23)	15
Midterm 2 (2.5 hour, testing center, Mar. 26-30)	15
Final Exam (3 hour, 392 CB, Friday. Apr. 16, 7:00 a.m.)	25
Homework	10
Quizzes	15
Laboratory	20
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	Total 100

Final letter grades are competitive (i.e. “on the curve”), based on your class rank for the combined scores in the assessments listed above. Grading will be normalized to the class average for each assessment listed to insure the stated weighting applies on average across the class.

2. EXAMS

All exams are timed, with open books and notes. Students may not take exams on other than the scheduled dates and times. If a midterm is missed due to an emergency situation or illness, the student may petition the professor to have the average grade for the remaining exams applied to the one missed. Exams must be entirely your own work.

Midterm exams will cover material up to and including any homework assignment due before the first day of the exam. The final exam will be comprehensive, but will emphasize new material introduced since the last midterm.

The time allotted for exams will require you to be efficient in solving problems, but should be sufficient if you are prepared. Speed in problem solving is an important skill to cultivate, and you should practice for speed with your homework and quizzes.

3. QUIZZES

In-class, 10-minute quizzes will be given approximately weekly on Friday mornings. Subject matter for the quizzes will be drawn from the lectures of the previous week. Since these are written by the professor immediately prior to class, and the solution

is presented in class immediately after the quiz, it is not possible to offer make-up quizzes at any other time. Please do not ask for a make-up or early quiz! If you miss the scheduled quiz for any reason (including illness and university excused absences) you will receive a zero score. To compensate for this, the lowest three quiz scores for each student will be dropped in final grade calculation.

4. HOMEWORK

Homework will be assigned and collected weekly. Due dates will typically be on Thursday evenings. Collection will be at 12:00 a.m. (midnight) in the homework box outside room 416 on evening of the assigned due date. As you may suspect, the grader may not always (ever) pick up the homework at exactly 12:00, but he will mark as late any homework he sees a student put in the box after that time. This is to avoid a cluster of students on the floor near the box finishing their homework, so just drop it in the box when you are done on the evening it is due.

I believe that completing the homework assignments is absolutely essential for mastering this difficult material. Each on-time submission of a serious solution attempt for a homework problem (even if it is wrong) will receive at least 75% credit. Solutions to the homework will be posted on the class web page one day after the due date. Late homework will be accepted for at most 40% credit on the problems worked. Since solutions are posted there will be no exceptions to permit full credit for late homework. Please review posted solutions to insure you understand the material in preparation for exams. I recommend that all homework be completed (even if late) to prepare for the exams.

Homework must be submitted on green engineering grid paper, using one side of the paper only. Fold the paper lengthwise and put your name and the homework set number on the outside for submission. Separate problems with a double horizontal line, work neatly, and put a box around your final answer (unless it is a large figure). Show a clear progression of your work towards a solution. Points will be deducted if the grader has difficulty finding and following what you have done.

Some homework assignments will include problems with MATLAB programming to give you some hands-on application experience. MATLAB is available on all the CAEDM machines and on the DSP lab machines in room 490. If you are unfamiliar with MATLAB, I suggest you begin immediately playing with it and familiarizing yourself with its basic syntax. On-line help is included for documentation on any built-in function. Just type "help *functions-name*."

Cooperative group study on the homework is encouraged, but simply copying someone else's work is unethical and will leave the student unprepared for exams. Much insight can be gained by studying with one or more groups, if you discipline yourself to find your own solutions first before comparing results. Rely on other's help only when you have exhausted all of you own ideas or have made no progress for 15 or 20 minutes. Remember, the exams will be totally your own work and

constitute the greater portion of the grade. I find the biggest contributor to excessive time spent on homework is failure to read the text material for understanding prior to attempting problems. The text is thorough and well written; take advantage of it!

5. RECITATION / HOMEWORK HELP SESSIONS

The scheduled discussion sessions are held weekly and are presented by the TA to assist you in mastering the lecture material and in completing the homework. Approximately half of the time will be spent with the TA presenting reinforcement material. i.e. homework examples, demonstrations, etc. The other half will be for question and answer exchange. Please come to the session having attempted all of the homework problems due that week so that you can ask insightful questions.

6. PREPARATION FOR LECTURES

Reading assignments will be given, and students are expected to come to class having completed the assigned reading. Students will be called on randomly to demonstrate their knowledge of the material by working problems on the board to assist the class in understanding the current discussion topic.

7. OFFICE HOURS

Dr. Jeffs' office hours are as follows:

Office Hours: Mon. and Wed., 10:00-11:00 a.m. & 3:00-5:00 p.m.

I will make every effort to be available in my office at these times. If you must meet with me at another time, feel free to check if I am in my office (MWF only). If I am available we can meet at that time, otherwise, I will be happy to make an appointment for another time. Please do not ask for technical help or an appointment by email, it takes too long to compose a technical response, or too many exchanges to find a mutually available meeting time. Due to other commitments, I will not be available for student consultation on Tuesdays or Thursdays.

8. LABORATORY

This is a DSP programming and demonstration laboratory. You will be developing software to implement signal processing applications on a programmable DSP processor board. As with all programming classes, the time you will spend is highly variable, and dependent on your skills (and luck?) as a software engineer. Developing efficient debugging skills will be most helpful to you in completing labs in a timely manner. Most of the programming will be in MATLAB.

The class will meet as a closed lab for three hours weekly in 490 CB. Labs are introduced in a 30 minute to 1 hour presentation by the professor on Thursdays as shown in the schedule above. This introductory lecture will help you get started on

the right foot for each lab assignment. Demonstrations of various aspects of the lab assignments will also be presented. The remainder of the time will be directed by the lab TA. These are closed labs! This means you are expected to be there the entire three hours, and that you should try to complete the experiments during the three hour block. There may be limited time available for make-up work in the labs during the other sections' regularly scheduled times, but ONLY if there is an open workstation (some sections are completely full). The TA will occasionally hold make-up sessions on a Saturday. If you need make-up lab time, schedule it with the TA, do not just show up. A key to completing the labs during the 3 hr. closed block is to read the lab assignment and complete all possible preparatory work before coming to the lab. The advantage of closed labs is that you will have a well trained TA there the entire time to assist you, thus you should spend much less time than in an open lab. You will need to pass off portions of your lab assignments to the T.A.s during their scheduled hours. All lab assignments must be completed to pass the class.

9. DOCUMENTING AND REPORTING LABORATORY WORK

All laboratory work should be recorded in a laboratory notebook (hardbound, engineering grid, etc.). This lab book should be new, or have at least 70 blank pages available. We will not be doing written reports, or abstracts, but you need to keep very thorough and neat records in your book. At the end of each lab assignment you will submit a copy of the pertinent pages in your lab notebook for grading by the T.A. Graphs, plots, and tables should be printed from the computer and pasted into the notebook.

For some of the experiments you will be explicitly instructed in the lab handout to have a T.A. "check off" operational performance. The T.A. needs to observe your functioning system, and will sign and date an entry in your lab book. Other experiments which do not require a check off must be documented clearly enough in the lab book to serve as evidence that you actually did the work. Do not just state that you completed the task; you should record observations, insights, operational conditions, problems, debug steps, etc. to document your effort. The lab record should include preparatory designs (including software), calculations, and a conclusions section at the end of each lab. Any new source code that you create or modify (some experiments request that you just run some existing code) should be printed and pasted into your lab book.

Lecture Schedule / Topics

<u>Dates:</u>	<u>Chap.</u>	<u>Pages</u>	<u>Topics</u>
Jan 4-11	3	99-138	Review of z-Transform and its properties.
Jan 13, 15	Handout		Inverse z-Transform using contour integration
Jan 20-27	4	179-224	Sampling and multirate signal processing
Jan 29-Feb 3	8	623-673	DFT, circular convolution, linear convolution from DFT
Feb 5-12	9	716-763	The Fast Fourier Transform.
Feb 16	5	288-301	Frequency response for rational system functions
Feb 17-24	5	493-532	Relationship between magnitude and phase, all-pass systems, minimum phase, generalized linear phase.
Feb 26-Mar 3	7	439-464	Filter design by impulse invariance and bilinear transform.
Mar 5-10	7	433-553	Windowed design of FIR filters.
Mar 12-17	7	554-582	Optimal approximations for FIR filter design.
Mar 19-24	12	942-969	Discrete Hilbert Transforms.
Mar 26, 29	Handout		Hilbert Transforms by complex bandshift.
Mar 31, 2	10	792-849	Time-dependent Fourier Transform and Periodogram.
Apr. 5-12	Handout		Applications: Speech, SONAR, Adaptive Filtering, etc.