

EE 8373 - Digital Speech Processing

Fall 2010

Course Catalog Description:

A detailed treatment of theory and application of digital speech processing. The course provides a fundamental knowledge of speech signals and speech processing techniques. Topics include digital speech coding, speech synthesis, speech recognition, and speech verification. *Prerequisite:* EE 7372

Time: TuTh 2:00-3:20 PM

Location: Caruth 184

Instructor: Panos Papamichalis

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E-mail: panos@engr.smu.edu

Office hours: Tue-Wed-Thu 11:00 AM – 12:00 PM

Teaching Assistant/Grader: TBA

Textbook:

Thomas Quatieri, *Discrete-Time Speech Signal Processing: Principles and Practice*, Prentice-Hall, 2002

References:

L. Rabiner & R. Schafer, *Theory and Applications of Digital Speech Processing*, Prentice-Hall, 2010

Course Topics:

1. Digital Models of Speech
2. Time-Domain Coding
3. Frequency-Domain Coding
4. Pitch; Formants; Homomorphic processing
5. Sinusoidal Speech Processing
6. Audio Signal Processing
7. Speech Recognition
8. Text-to-Speech Synthesis; Standards

Grading Policy:

Homework/Projects 60%

In-class mid-term 20% (open book and notes)

Final 20% (Tentatively: 10% in class (open book and notes), 10% take-home)

Graduate Program Outcomes (SACS, ABET)

Program outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program.

Outcome (I): An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Performance Criteria		Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4
I.1	Identify a technique appropriate for engineering practice	Identifies a technique inappropriate for a given application.	Identifies a technique somewhat appropriate for a given application.	Identifies a technique appropriate for a given application.	Identifies the best technique for a given application.
I.2	Demonstrate an appropriate skill level using a specified technique for engineering practice	Demonstrates a poor skill level using a specified technique for a given application.	Demonstrate a modest skill level using a specified technique for a given application.	Demonstrate a satisfactory skill level using a specified technique for a given application.	Demonstrates an excellent skill level using a specified technique for a given application.
I.3	Identify a modern engineering tool appropriate for engineering practice	Identifies a modern engineering tool inappropriate for a given application.	Identifies a modern engineering tool somewhat appropriate for a given application.	Identifies a modern engineering tool appropriate for a given application.	Identifies the best modern engineering tool for a given application.
I.4	Demonstrate an appropriate skill level using a specified modern engineering tool for engineering practice.	Demonstrates a poor skill level using a specified modern engineering tool for a given application.	Demonstrates a modest skill level using a specified modern engineering tool for a given application.	Demonstrates a satisfactory skill level using a specified modern engineering tool for a given application.	Demonstrates an excellent skill level using a specified modern engineering tool for given application.

Outcome (II): Ability to apply knowledge of mathematics, science, and engineering

Performance Criteria		Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4
II.1	Turn a problem statement into an analytical	Cannot connect problem statements to analytical model.	Can interpret parts of the problem analytically, but cannot find a	Can find some way(s) to formulate the problem, but not	Can quickly find an efficient clear and precise analytical

	model		complete solvable approach.	always the most direct.	representation of the problem statement
II.2	Identify appropriate method for solving specified problem	Identifies inappropriate methods or no method at all.	Identifies a related technique for part of the problem.	Identifies an appropriate method.	Identifies an innovative and effective method.
II.3	Execution of method	Cannot solve a mathematically posed relationship.	Can take several steps towards the solution, but not complete it.	Arrives at the correct answer through a rather indirect path.	Quickly finds an innovative way to solve the problem.

Outcome (III): Ability to identify, formulate, and solve engineering problems

Performance Criteria		Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4
III.1	Problem Identification	Unable to perceive that there is a problem.	Observes that there is a problem but lacks ability to articulate it.	Can identify and describe the problem.	Can identify not only the evident problem but also any related problems.
III.2	Problem Formulation	Unable to formulate the problem.	Can partially formulate the problem.	Can formulate the problem.	Can quickly find an efficient formulation of the problem
III.3	Problem Solving	Unable to solve the problem.	Can take several steps towards the solution, but not complete it.	Arrives at the correct answer.	Efficiently arrives at the correct answer.
III.4	Trouble Shooting	Unable to narrow down symptoms	Isolates problem to an specific area but does not identify causal mechanism	Able to isolate and solve problem	Develops structured and efficient method that results in solution

Outcome (IV): Ability to communicate effectively

Performance Criteria		Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4
IV.1	WRITTEN: Content	Written work does not cover the assigned topic, and assertions are not supported by evidence.	Written work does not do an adequate job of covering the assigned topic, and assertions are weakly supported by evidence.	The length of the written work is sufficient to cover the topic, and assertions are supported by evidence.	The length of the written work provides in-depth coverage of the topic, and assertions are clearly supported by evidence.
IV.2	WRITTEN: Structure	Organizational structure and paragraphing	Written work has weak beginning, development and	Written work has adequate beginning,	Written work has clear and appropriate

		have serious and persistent errors.	conclusion. Paragraphing and transitions are also deficient.	development and conclusion. Paragraphing and transitions are also adequate.	beginning, development and conclusion. Paragraphing and transitions are also clear and appropriate.
IV.3	WRITTEN: Mechanics	Written work has serious and persistent errors in word selection and use, sentence structure, spelling, punctuation, and capitalization	Written work has several major errors in word selection and use, sentence structure, spelling, punctuation, and capitalization.	Written work is relatively free of errors in word selection and use, sentence structure, spelling, punctuation, and capitalization.	Written work has no major errors in word selection and use, sentence structure, spelling, punctuation, and capitalization.
IV.4	WRITTEN: Reference & Citations	Documents almost no references and citations correctly according to an accepted style.	Documents less than half of the references and citations correctly according to an accepted style.	Documents almost all references and citations correctly according to an accepted style.	Documents references and citations correctly according to an accepted style.

Performance Criteria		Unsatisfactory 1	Developing 2	Satisfactory 3	Exemplary 4
IV.5	ORAL: Organization	Audience cannot understand presentation because there is no sequence of information.	Audience has difficulty following presentation because student jumps around.	Student presents information in logical sequence which audience can follow.	Student presents information in logical, interesting sequence which audience can follow.
IV.6	ORAL: Subject Knowledge	Student does not have grasp of information; student cannot answer questions about subject.	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student is at ease with expected answers to all questions, but fails to elaborate.	Student demonstrates full knowledge (more than required) by answering all class questions with explanations and elaborations.
IV.7	ORAL: Elocution	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the	Student's voice is low. Student incorrectly pronounces terms. Audience member have difficulty hearing presentation.	Student's voice is clear. Student pronounces most words correctly. Most audience member can	Student uses a clear voice an correct, precise pronunciation of terms so that all audience members can hear presentation.

		back of the class to hear.		hear presentation.	
IV.8	ORAL: Visual Aids	Little organization, unclear subject matter with poor visual aids.	Sections of the presentation are clear but many areas are confusing with poor visual aids.	Clear presentations that could have been more concise with adequate visual aids.	Clear concise presentations with exceptional visual aids and smooth transitions between topics.

Course Material:

Online course material will be posted regularly to the course Blackboard (Bb) <http://courses.smu.edu/>. Please be reminded that your Bb *password* is the same as the one for your *access.smu*.

MATLAB:

Homeworks and the Final will require the use of MATLAB. Computers with MATLAB and the Signal Processing Toolbox installed are available in Junkins Laboratories. It is **NOT** required, but you are free to buy yourself a student edition of MATLAB. You may purchase it either from the SMU Computer Corner or from the MathWorks Inc. <http://www.mathworks.com/academia/>.

Homework Assignments:

- The homework assignments will contain MATLAB-based problems, but they may also contain problems of the analytical type. MATLAB problems will require you to process signals and then view and/or listen to them. The processing should be done using MATLAB, and all the MATLAB files should accompany your solutions, to be able to duplicate your results.
- The homework assignments will be posted electronically on the Blackboard. The homework submission should also be done electronically on the Blackboard,. Please scan any hand-written comments and post them as PDF files. (More instructions will be given with the assignments.)
- The deadline for posting the assignments is midnight of the day the assignment is due. **No late homework will be accepted**, unless the student has contacted the instructor ahead of the deadline and got permission for a late submission.
- For Distance Education students, a streaming video of the lecture will be posted on-line at the URL of the Online Distance Classes soon after the lecture. Lecture notes will also be posted on the Blackboard. **Therefore, both on-campus and distance students will have the same deadlines for homework and final submission.**

Homework Self-Grading:

You will be grading your own homework, in order to better understand what you did right or wrong. The grading will be done according to the following guidelines:

- After you submit your homework on the Blackboard, the solutions will be given to you.
- Grade your homework based on the solutions.
 - For each problem, give a grade between zero and the maximum number of points indicated in the homework assignment.
 - For a problem with different parts, divide the total number of points equally between the parts.
 - If you have to subtract points from a problem, write on your homework what you did wrong.
 - If you make a mistake in a problem and there is a follow-up question depending on this (mistaken) outcome, subtract the appropriate points from the first question, but assume that it is correct when grading the follow-up question.
 - If you have a different approach from the solutions but you claim they are equivalent, verify that you get the same results. If you do, write a note on that and give yourself full credit.
 - For each problem, round your grade to the nearest integer.
- The grading should reflect your level of understanding of the concepts. For instance, if you have a “+” sign in an expression instead of a “-“ sign because you copied it wrong, this is a small mistake. But if you have the same sign change because you did not understand what the operation does, this is a serious mistake.
- The graded homework is due within two days from the time the solution was given. You have two options for submitting the graded homework:
 - You can write comments and the grades on the actual homework and submit it in Blackboard.
 - You write your comments and the grade for each problem in an e-mail (or e-mail attachment) and send it to me.
- I reserve the right to adjust your self-grade, if necessary.

Some Rules and Expectations:

- Grades will be posted to the blackboard. If you have any questions about the grades, make sure to contact the instructor no later than one week after the posting date.
- **Adherence to the SMU Honor code will be strictly enforced.** You may consult (seek opinion or advice from) your classmates but you must submit your individual work. Copying or modifying working programs or reports will be considered as cheating and will not be accepted.

Incomplete Policy:

An Incomplete(I) may be given if the majority of the course requirements have been completed with passing grades but for some justifiable reason acceptable to the instructor, the student has been unable to complete the full requirements of the course. Before an (I) is given, the instructor should stipulate in writing to the student the requirements and completion date that are to be met and the grade that will be given if the requirements are not met by the completion date. The maximum period of time allowed

to clear the Incomplete grade is 12 months (except for graduate thesis and dissertation courses.) If the Incomplete grade is not cleared by the date set by the instructor or by the end of the 12-month deadline, the (I) may be changed to an F, WP or other grade, each of which is prescribed for other specific purposes. If the student's work is incomplete and the quality has not been passing, an F will be given. The grade of (I) does not authorize the student to attend the course during a later semester. Graduation candidates must clear all Incompletes prior to the deadline in the University Calendar, which may allow less time than 12 months. Failure to do so can result in removal from the degree candidacy list and/or conversion of the (I) to the grade indicated by the instructor at the time the (I) was given.

Disability Accommodations:

If you need academic accommodations for a disability, you must first contact Disability Accommodations & Success Strategies (DASS) at 214-768-1470 or www.smu.edu/alec/dass.asp to verify the disability and to establish eligibility for accommodations. Then you must schedule an appointment with the professor to make appropriate arrangements.

Religious Observance:

Religiously observant students wishing to be absent on holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

Excused Absences for University Extracurricular Activities:

Students participating in an officially sanctioned, scheduled University extracurricular activity will be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (University Undergraduate Catalog)

Academic Honesty

Academic dishonesty may be defined broadly as a student' misrepresentation of his or her academic work or of the circumstances under which the work is done. This includes plagiarism in all papers, projects, take-home exams, or any other assignments in which the student represents work as being his or her own. It also includes cheating on examinations, unauthorized access to test materials, and aiding another student to cheat or participate in an act of academic dishonesty. Failure to prevent cheating by another may be considered as participation in the dishonest act.

The SMU Honor Code (http://www.smu.edu/studentlife/PCL_05_HC.asp) states:

“Intellectual integrity and academic honesty are fundamental to the process of learning and of evaluating academic performance, and maintaining them is the responsibility of all members of an educational institution. The inculcation of personal standards of honesty and integrity is a goal of education in all the disciplines of the University. The faculty has

the responsibility of encouraging and maintaining an atmosphere of academic honesty by being certain that students are aware of the value of it, that they understand the regulations defining it, and that they know the penalties for departing from it. The faculty should, as far as is reasonably possible, assist students in avoiding the temptation to cheat. Faculty members must be aware that permitting dishonesty is not open to personal choice. A professor or instructor who is unwilling to act upon offenses is an accessory with the student offender in deteriorating the integrity of the University. Students must share the responsibility for creating and maintaining an atmosphere of honesty and integrity. Students should be aware that personal experience in completing assigned work is essential to learning. Permitting others to prepare their work, using published or unpublished summaries as a substitute for studying required materials, or giving or receiving unauthorized assistance in the preparation of work to be submitted are directly contrary to the honest process of learning. Students who are aware that others in a course are cheating or otherwise acting dishonestly have the responsibility to inform the professor and/or bring an accusation to the Honor Council. Students and faculty members must mutually share the knowledge that any dishonest practices permitted will make it more difficult for the honest students to be evaluated and graded fairly and will damage the integrity of the whole University. Students should recognize that both their own interest, and their integrity as individuals, suffers if they condone dishonesty in others.”

Calendar:

August 24	First Day of Classes
October 11-12	Fall Break
(October 19)	(Mid-term Exam)
November 05	Last Day to Drop a Course
November 25	Thanksgiving Holiday
December 02	Last Day of Instruction for this class
(December 10)	(Final Exam)

Schedule:

Lecture	Date	Topic	Comments
1	08.24	Introduction (Ch 1, 2)	
2	08.26	Digital Models of Speech (Ch 3, 4)	Assignmt #1 (due 09.14)
3	08.31		
4	09.02		
5	09.07		
6	09.09	Time-Domain Coding (Ch 12.1-12.3)	
7	09.14		Assignmt #2 (due 09.28)
8	09.16		
9	09.21	Frequency-Domain Coding (Ch 5, 7, 8, 12)	
10	09.23		
11	09.28		Assignmt #3 (due 10.14)
12	09.30		
13	10.05		
14	10.07		
	10.12	Spring Break – No Class	
15	10.14	Pitch; Formants; Homomorphic (Ch 6, 10)	Assignmt #4 (due 10.28)
16	10.19	Mid-term exam	
17	10.21		
18	10.26	Sinusoidal Speech Processing (Ch 9)	
19	10.28		Assignmt #5 (due 11.11)
20	11.02	Audio Signal Processing (Ch 13)	
21	11.04		
22	11.09		
23	11.11	Speech Recognition (Ch 14)	Assignmt #6 (due 11.30)
24	11.16		
25	11.18		
26	11.23		
27	11.25	Thanksgiving Holiday	
28	11.30	Text-to-Speech; Standards	
29	12.02		
Final	12.10	(3:00-6:00 PM) Take Home	Out: 12.06 – Due: 12.09