PURDUE UNIVERSITY

DEPARTMENT OF SPEECH, LANGUAGE, AND HEARING SCIENCES

SIGNAL PROCESSING FOR HEARING AND SPEECH SCIENCES
SLHS 658 - SPRING 2009

Time: Tuesday 8:30-11:20
Room: BRNG B282
Credits: 3

Professor: Michael G. Heinz, Ph.D.
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"TA" Email: SLHS658.TA.Sp09@gmail.com
Office Hours: TBD

Required Text: Signals and Systems for Speech and Hearing, by Rosen & Howell
Supplemental Material: several MATLAB tutorials posted on Blackboard

Required Software: MATLAB (see handout on options for accessing MATLAB)
MS Office (Word and PowerPoint)

Course Description: This course provides an overview of the fundamental theory of signals and systems analysis with applications to hearing and speech sciences. Topics include: Introduction to MATLAB, time and frequency domain characterizations of signals and of systems, analyses of signals through systems, time/frequency relations, spectrograms, applications to hearing (e.g., hearing-aid and cochlear-implant signal processing), applications to speech, and digital signal processing. Practical experience with digital signal processing (primarily in MATLAB) will supplement lectures. No explicit background in signal processing or MATLAB is assumed.

Assumed Background: This course is designed for AuD and PhD students. Although this is a course on signal processing and MATLAB, no explicit background in either is assumed. It is assumed that students have had algebra and trigonometry, but it is not assumed that students have had calculus. Basic use of MS Office is assumed, but details related to this course will be provided. If you have any questions about your background for this course, please discuss them with me.

Course Goals

1) To develop a basic understanding of the principles of signals and systems analysis for application to hearing and speech sciences.
2) To gain hands-on experience with signal processing, data analysis, and programming using MATLAB.
3) To use MATLAB as a tool to develop a greater depth of understanding of issues in signals and systems analysis and in hearing and speech sciences.
4) For each student to identify the types of applications MATLAB could be useful for in their future path.

Course Overview:
This course seeks to make signal-processing and programming fundamentals accessible to SLHS students by giving them extensive hands-on experience using MATLAB. Although much of the work will involve the use of MATLAB, the focus will be at the conceptual level. The course structure is specifically designed to achieve this goal.

The first hour of each class will be a lecture that presents fundamental concepts in signals and systems analysis without any detailed mathematics. The second hour of each class will consist of in-class demonstrations using MATLAB, where code will be presented to demonstrate the theoretical concepts presented in the first hour. The third hour will typically be used for open lab time, where students will work with the provided MATLAB code and ask questions individually. Problem Sets will be assigned each week that will provide hands-on experience using and modifying the code presented in class to develop a greater depth of understanding of the theoretical concepts. There will be paper discussions later in the semester to present some relevant signal processing applications to hearing and speech science.

The in-class demos and problems sets throughout the term will result in a course toolbox of MATLAB code for performing many of the basic functions in signals and systems analyses that are often applied to hearing and speech sciences. This toolbox will provide the basis for each student's final project, which will address a relevant and interesting application in hearing and speech science of each student's choice and design. The final projects will be presented to the class by each student during the final week of the semester. There will be no final exam.

Grading policy:
A main goal of this course is to learn to use MATLAB and the only way to do this is to use it often. Therefore, the combination of problem sets and the project will account for 90% of the grade. To encourage active involvement in this course, participation will be counted for 10%.

Problem Sets	50%
Final Project (20% content, 10% oral presentation, 10% written)	40%
Participation (in class, online discussion, office hours, …)	10%

Problem Sets:
A problem set will be assigned weekly, which will involve MATLAB work, problems based on the lectures, and write-ups in MS WORD. These assignments must be submitted on paper and emailed by the beginning of the next class. Late assignments will not be permitted (except in extenuating circumstances), because solutions (e.g., fully commented code) may be discussed in class. All assignments will be graded initially based on a quick (few minutes) in-lab (3^{rd} hour of class) demonstration of your MATLAB code to me. Four problem sets (randomly spread through the semester) will be graded in more depth after class. All problem sets will be equally weighted. Solutions will typically be provided at the end of class on the due date.

Advice: *Given the limited experience of most students in using MATLAB, there are going to be many places for you to get stuck (e.g, not knowing how to run MATLAB – 1^{st} week only!, not knowing a certain command to use in MATLAB, etc …). You are going to need to learn how to get unstuck quickly so that you can complete each assignment, and the best way is to start early and to ask questions early and often (e.g., in class, online discussions, office hours, email). Your fellow students (see statement below on collaborative work) and the "email TAs" are good resources for getting unstuck.*

Final Projects:
Projects will be completed over the last few (~4) weeks of the semester, and will be presented to the class during the final week of the semester. Projects represent an opportunity for each student to take the basic skills we have developed through the semester and to use MATLAB in a way that is of interest to them. MATLAB is an incredibly versatile tool, and the interests and backgrounds of the students are broad, so projects will be found that are appropriate to each students' background and interests. Students will propose a project near the beginning of the 2nd half of the semester and an appropriate extent of the project will be agreed upon through discussions with me. Remember, one of the primary goals of this course is for each student to learn how to use MATLAB in ways that will be useful to them after the course. A list of projects ideas will be provided later in class.

Access to MATLAB (see handout):
This course will require access to MATLAB and MS Office in order to complete the weekly problem sets and final project. It is each student's responsibility to find a reliable environment in which to do the work for this course. This should be worked out within the first week of class, and will not be accepted as an excuse for incomplete work after the first week. I am happy to help work this out on an individual basis during the first week.

Blackboard (online):
Materials from the course will be posted on Blackboard and students will be expected to download MATLAB code and other MS Office documents from Blackboard in order to complete the assignments in class (material may also be emailed).

One component of Blackboard that was particularly useful the last time this course was taught was the Online Discussion Board. I would like students to use this as a resource for sharing general and specific MATLAB knowledge across the class (no sharing of code, but sharing of command names or HOWTO sorts of things, etc …). As mentioned above, there are going to be plenty of places to get stuck with assignments. I encourage you to use the Online Discussions to ask HOWTO questions when you get stuck, and to share your knowledge with the class when you know the answer. Note: both asking and answering questions online will directly contribute to your grade through the 10% for participation! In addition to online discussion, individual questions can be asked via the "TA email" (SLHS658.TA.Sp09@gmail.com).

Statement on Collaborative Work:
The skills to be learned in this course rely on each student doing and understanding the assignments themselves. However, MATLAB is a programming language in which there are specific commands for performing operations, and not knowing the name of that command can prevent a student from proceeding. There is plenty of online help available in MATLAB, which should solve many of problems, but it is not likely to solve them all. Collaboration is encouraged in ways that help to avoid students getting stuck and not being able to complete an assignment (e.g., how to access MATLAB, how to export a figure, how to copy a file, not knowing the name of a specific MATLAB command, etc …). These situations will benefit from shared knowledge across the class (e.g., via online discussions, etc …). However, this is not an excuse for simply copying code from another student (there are plenty of ways to tell when sections of code have been copied). Each student is expected to write their own code (e.g., provide their own variable names, comments, and logic when applicable) .

Students with Disabilities
Students with disabilities must be registered with Adaptive Programs in the Office of the Dean of Students before classroom accommodations can be provided. If you have a disability that requires academic adjustments, please discuss your needs with me as soon as possible.

Course Flexibility in the Case of Unexpected Emergencies
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Here are ways to get information about changes in this course. Blackboard Vista web page, my email address: mheinz@purdue.edu, and my office phone: 496-6627. Additional suggestions for best practices in the case of a campus emergency are available at: http://www.itap.purdue.edu/tlt/faculty/.

Course Schedule (tentative):
Note: Readings listed on the syllabus for each week are the readings that correspond to the material discussed that week, and thus should be read prior to class each week.

Week	Date	Topic	Reading
1	**1/13**	**Overview, Intro to MATLAB**	**Ch. 1**
2	**1/20**	**Introduction to Signals**	**Ch. 2, 3**
3	**1/27**	**Introduction to Systems**	**Ch. 4, 5**
4	**2/3**	**Frequency Response of Systems**	**Ch. 6**
5	**2/10**	**Frequency Characterization of Signals**	**Ch. 7**
6	**2/17**	**Signals Through Systems**	**Ch. 8**
7	**2/24**	**Time Characterization of Signals**	**Ch. 9**
8	**3/3**	**Time/Frequency Domain Relations**	**Ch. 10**
9	**3/10**	**Spectrograms**	**Ch. 11**
10	**3/17**	**SPRING BREAK**	
11	**3/24**	**Applications to Hearing**	**Ch. 12**
12	**3/31**	**Paper Discussions: Cochlear Implant Signal Processing**	**TBA**
13	**4/7**	**Applications to Speech**	**Ch. 13**
14	**4/14**	**Digital Systems**	**Ch. 14**
15	**4/21**	**Real-Time Digital Signal Processing**	**TBA**
16	**4/28**	**Final Project Presentations**	
17	**5/5**	**EXAM WEEK – Final Paper due Tuesday 5/5 at 5pm.**	