Detailed Syllabus for CSS 457

Multimedia and Signal Computing

As computers become ubiquitous, they become more and more embedded not only in the devices we own and use but in our lives. As a result, computers become embedded in the physical world, with their primary purpose being to detect and analyze happenings in our world and to produce responses that affect that world. As computing professionals, we need to understand how computers can process information from the physical world as *digital signals*: multimedia (sound, images, video) and other measurements (in medical instruments, cars, cell phones, eyeglasses, etc). This is "Signal Computing". Digital signals place great demands on processing power, network bandwidth, storage capacity, I/O speed, and software design. As a result, signal computing is a great laboratory for exercising the full range of knowledge of computer science.

While there certainly may be many opportunities for you to work in signal computing, the value of this study extends far beyond. Studying signal computing and its underlying mathematics directly exercises key computer science abilities in areas like abstraction and algorithmics. As this course progresses, we take a familiar representation of digital signals or operations, reach a concept in which it is awkward or difficult to use, and then develop an alternative representation that simplifies matters. This is exactly what computing professionals do in their careers -- identify that a problem at hand can be represented by some abstraction with known properties that can be manipulated by well-understood algorithms.

The specific topics we will cover include: physical properties of multimedia source information (sound, images), devices for information capture (microphones, cameras), digitization, compression, digital media representation (JPEG, MPEG), digital signal processing, and network communication. By the end of this course, you will understand the problems and solutions facing multi/hypermedia systems development in the areas of user interfaces, information retrieval, data structures and algorithms, and communications. As a result, you should be well-prepared to work with electrical engineers in the design of advanced signal processing systems (for example, wireless communication devices or biomedical instrumentation) and multimedia computing systems.

Course Objectives

The goals of this course are for you to learn:

- How to use alternative mathematical representations of problems as tools to make problem solving simpler.
- What signals are like in the “real” world and how the properties of multimedia signals (sounds,

images, video) affect how we perceive them.
- How signals get into the computer, how they are represented within the computer, and the tradeoffs among sampling speed, levels of quantization, and file size.
- What are the basic algorithms that perform simple signal processing to remove noise, emphasize important features, etc.
- How multimedia file sizes can be reduced by compression, and the tradeoffs among compression, processing overhead, and media quality.
- How these concepts are applied in multimedia applications and standards.

ABET Student Outcomes

For engineering accreditation purposes, this course supports the following ABET student outcomes:

- a) An ability to apply knowledge of mathematics, science, and engineering
- b) An ability to design and conduct experiments, as well as to analyze and interpret data
- g) An ability to communicate effectively
- k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Prerequisites

This course covers much of the mathematical foundations for understanding signals and signal processing, however, it is assumed that you are familiar with topics such as complex numbers, trigonometry, derivatives, vectors, the basic idea of integrals, infinite series, and basic physics (mass, acceleration, force). CSS 342 and lower division math courses are the only formal prerequisites. While we will do some programming, and your project will no doubt involve programming, we will use it more as a tool than an end in itself — this is not a programming course.

Instructor

Michael Stiber **stiber@uw.edu (mailto:stiber@uw.edu)** , office in room UW1-360D, phone (425) 352-5280, office hours Mondays 1:30-2:30PM in room UW1-271, or by appointment.

Textbook

M. Stiber, B. Stiber, and E.C. Larson, Signal Computing: Digital Signals in the Software Domain, **available online (http://faculty.washington.edu/stiber/pubs/Signal-Computing/)** .

Laboratory Manual

M. Stiber, B. Stiber, and E.C. Larson, Signal Computing: Digital Signals in the Software Domain — Laboratory Manual, **available online** **(http://faculty.washington.edu/stiber/pubs/Signal-Computing/)** .

On reserve

The following books are also on reserve in the library for further reading:

- Martin D. Levine, *Vision in Man and Machine*, McGraw-Hill, 1985, chapter 1, chapter 2 (§ 2.1, 2.2).
- James H. McClellan, Ronald W. Schafer, and Mark A. Yoder, *DSP First: A Multimedia Approach*, Prentice Hall, Upper Saddle River, NJ, 1999.
- Ken Pohlman, *The Compact Disc Handbook*, A-R Editions, 1992.
- Curtis Roads, *The Computer Music Tutorial*, MIT Press, 1996.
- Richard Boulanger and Victor Lazzarini, eds., *The Audio Programming Book*, MIT Press, 2010.

Laboratories

You will be completing laboratories for the homework portion of this course. Each laboratory will involve a section of the laboratory manual describing what you are to do, using Matlab. You will write up a laboratory report and submit it in Canvas on the due date. A **rubric** **(https://canvas.uw.edu/courses/1075104/pages/laboratory-report-rubric)** is available on Canvas that describes the elements of a good report. With the exception of labs 1 and 2, I will *not* accept non-trivial late reports (where non-trivial means more than an hour past the deadline) -- in fact, I have set up Canvas so you will be unable to submit reports after that time. The only exceptions are labs 1 and 2; for those labs only, I will accept reports up to one day late, with a 20% penalty. Like any course, pay attention to due dates and times in Canvas.

Final Project

You will be expected to complete a final project of your own choosing (after receiving approval from me). I know that the quarter system does not lend itself especially well to projects; we will spend some time in class brainstorming possibilities, but you will need to look ahead in the course material to consider how you can plan out a project based on what you have learned and what remains to be covered. The project can either be a group project or an individual project. I strongly encourage you to do a group project, as such a project would be far more substantial (and it would be physically impossible to have 40+ project presentations in class). However, I do not absolutely require group projects.

Project Milestones

1. Project Conference. **One of your assignments (https://canvas.uw.edu/courses/1075104/assignments/3331048)** will be to have your group formed and make an appointment online with me to meet with me to discuss your project

ideas and give you feedback regarding the scope and workload. You will have only 15 minutes, so *come prepared* to present your ideas and ask specific questions (you probably should have spent at least a half dozen or so hours per team member working on the project before meeting with me). This is *not* meant to be a time to fish around for ideas from me: you should already have your own by then. Think of this as an oral project proposal/pitch; you should expect to come out of the meeting with me with my buy-in and perhaps some ideas or pointers for modifications or extensions that were necessary to secure my buy-in.

2. Project Interim Report. Roughly half-way through the project work you will submit a progress report that outlines your overall project plan and status, including what you plan to do by the final project submission date.
3. Project Presentation. You will make a short (10-15 minute) presentation to the class on your project near the end of the quarter. Your project may not be 100% complete at that point in time, but it should be substantially complete enough to present to the class. I have **some suggestions (https://canvas.uw.edu/courses/1075104/pages/presentation-suggestions)** for such presentations.
4. Project Final Report. Your final report will be due Wednesday of finals week. Think back to what you learned in CSS 301; I provide **detailed guidelines (https://canvas.uw.edu/courses/1075104/pages/final-project-report-guidelines)** for your final report, too.

Class Preps

Associated with each reading from the textbook will be a *class prep*. A class prep is an online survey that you are asked to complete *before* the classes associated with that reading. The scheduling goal for this class is for each class prep to be due on a Sunday night, for the reading relevant to the coming week. Class preps are meant to accomplish two things:

1. To encourage and reward you for reading and thinking about topics before we discuss them in class.
2. To guide in-class discussion.

The first is accomplished, on the one hand, because you will be much better prepared to take advantage of class time and, on the other hand, because you will receive credit for doing the class prep (each prep is graded satisfactory/unsatisfactory; the bar may not be very high, but it is possible to submit a prep that is unsatisfactory). The second is relevant because I will use the feedback, questions, and requests in the submitted class preps to guide our class activities — in other words, if a topic receives few or no questions from anyone in the preps, then we will spend little or no time on it when we meet.

Pre-labs

On the day that each lab is assigned (generally, a Monday), you will spend some time in class with a partner working on a set of pre-lab exercises; this is also the person with whom you will do the lab. You should set up your lab group at that time (or earlier; see **People (https://canvas.uw.edu/courses/1075104/users)**). One member of each group (the first person to join) will be the leader who should submit the pre-lab -- I will manually give the other group member credit for it.

We will then go over any questions regarding the exercises. Each pre-lab is graded satisfactory/unsatisfactory; an honest effort on the questions is required for a satisfactory evaluation.

Access and Accommodations

Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 425-352-5307 or **uwbdrs@uw.edu (mailto:uwbdrs@uw.edu)** . DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s), and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

For Our Veterans

If you are a student who has served in our nation's military forces, *thank you* for your service. I hope that you feel comfortable enough to confidentially self-identify yourself to me so I can help you make a successful transition from the military to higher education.

Problems

If you have problems with anything in the course, please come and see me during office hours, make an appointment to see me at some other time, or send email. I want to make you a success in this course. Laboratory reports/deliverables represent hard deadlines; this is to prevent your schedule from slipping so much that you won't be able to complete the class. I will not give out grades of "incomplete" except in extreme circumstances.

Weekly Workflow

With some exceptions (for example, the first week and the week of the midterm), the following summarizes your workflow for this class:

1. Read the chapter/sections of the textbook assigned. Do the self-test exercises. Take good notes, including any questions you may have.
2. Complete the class prep for the reading in Canvas — *due Sunday night*. These are graded

satisfactory/unsatisfactory.

3. Discuss the material in class.
4. Do the pre-lab, with a partner, in class. (Mondays) These are graded satisfactory/unsatisfactory.
5. Do the lab — *due following Monday night*.

Grading

30% labs + 25% exam + 25% project + 10% class preps + 10% pre-labs

Etiquette, Etc.

- This is intended to be a highly interactive class. Of the various things you'll be doing this quarter, only the exam will be done solely by yourself. I either require or strongly suggest that you do everything else with one or more partners. This means you need to be engaged both in and out of class -- others are depending on you.
- You are expected to provide original work based on your own effort for this course. You will receive a zero for any coursework for which you are discovered cheating or plagiarizing. You will be referred to the University for further action. It is your responsibility to know and uphold the Student Conduct Code for the University of Washington, available at **http://www.uwb.edu/students/policies/ (http://www.uwb.edu/students/policies/)** .
- As far as the exam is concerned, I hope I don't need to remind anyone that it's not acceptable to take a break in the middle -- i.e., leave the room for any reason -- and expect to be able the resume taking the exam afterwards. It's not a matter of me doubting your honesty -- it's a matter of you, as a professional, avoiding doing anything that might even hint at being less than honest and focused on the task at hand. Please ensure that you've either taken care of any personal matters before the exam (or provide me with documentation of a medical condition that precludes spending two hours at uninterrupted work).
- Please use your UW email (*netid*@uw.edu) for communications with me. This is the only way that I can authenticate that you are who you say you are. I will endeavor to only email you at that address. I do this because that address is the only one guaranteed to be connected to you, based on information in the student database.

CSS 457 A: Multimedia And Signal Computing

Jump to Today ✎ Edit

Multimedia and Signal Computing: Course Summary

Please see this page for a detailed syllabus!

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Course Summary:

Date	Details

Wed Sep 28, 2016	Class 1: introduction, math foundations (https://canvas.uw.edu/calendar?event_id=916617&include_contexts=course_1075104)	11am to 1pm
	Pre-lab 1 (https://canvas.uw.edu/courses/1075104/assignments/3331023)	due by 1:05pm
Sun Oct 2, 2016	Class Prep 1: ch. 1, ch. 2 (2.1) (https://canvas.uw.edu/courses/1075104/assignments/3331025)	due by 11:59pm
Mon Oct 3, 2016	Class 2: signals in the physical world; an example application (https://canvas.uw.edu/calendar?event_id=916616&include_contexts=course_1075104)	11am to 1pm
	Pre-lab 2 (https://canvas.uw.edu/courses/1075104/assignments/3331029)	due by 1:05pm
	Lab 1 (https://canvas.uw.edu/courses/1075104/assignments/3331039)	due by 11:59pm
Wed Oct 5, 2016	Class 3: spectra; signals in the computer: introduction to digitization (https://canvas.uw.edu/calendar?event_id=916618&include_contexts=course_1075104)	11am to 1pm
Sun Oct 9, 2016	Class Prep 2: ch. 2, ch. 3 (3.1-3.2.2) (https://canvas.uw.edu/courses/1075104/assignments/3331030)	due by 11:59pm
Mon Oct 10, 2016	Class 4: noise, sampling (https://canvas.uw.edu/calendar?event_id=916619&include_contexts=course_1075104)	11am to 1pm
	Pre-lab 3 (https://canvas.uw.edu/courses/1075104/assignments/3331033)	due by 1:05pm
	Lab 2 (https://canvas.uw.edu/courses/1075104/assignments/3331040)	due by 11:59pm
Wed Oct 12, 2016	Class 5: quantization; introduction to filtering (https://canvas.uw.edu/calendar?event_id=916620&include_contexts=course_1075104)	11am to 1pm
Sun Oct 16, 2016	Class Prep 3: ch. 3 (https://canvas.uw.edu/courses/1075104/assignments/3331035)	due by 11:59pm
	Class 6: feedforward filters (https://canvas.uw.edu/calendar?event_id=916621&include_contexts=course_1075104)	11am to 1pm

Mon Oct 17, 2016	Pre-lab 4 (https://canvas.uw.edu/courses/1075104/assignments/3331037)	due by 1:05pm
	Lab 3 (https://canvas.uw.edu/courses/1075104/assignments/3331041)	due by 11:59pm
Wed Oct 19, 2016	Class 7: feedforward filters, cont'd (https://canvas.uw.edu/calendar?event_id=916622&include_contexts=course_1075104)	11am to 1pm
Fri Oct 21, 2016	Project Conference Sign-up (https://canvas.uw.edu/courses/1075104/assignments/3331048)	due by 11:59pm
Sun Oct 23, 2016	Class Prep 4: ch. 4 (https://canvas.uw.edu/courses/1075104/assignments/3331036)	due by 11:59pm
Mon Oct 24, 2016	Class 8: the Z-transform (https://canvas.uw.edu/calendar?event_id=916623&include_contexts=course_1075104)	11am to 1pm
	Pre-lab 5 (https://canvas.uw.edu/courses/1075104/assignments/3331024)	due by 1:05pm
Wed Oct 26, 2016	Class 9: convolution and properties of the Z-transform (https://canvas.uw.edu/calendar?event_id=916624&include_contexts=course_1075104)	11am to 1pm
	Lab 4 (https://canvas.uw.edu/courses/1075104/assignments/3331042)	due by 11:59pm
Fri Oct 28, 2016	Project Conference (https://canvas.uw.edu/courses/1075104/assignments/3349664)	due by 11:59pm
Sun Oct 30, 2016	Class Prep 5: ch. 5 (https://canvas.uw.edu/courses/1075104/assignments/3331028)	due by 12:59am
Mon Oct 31, 2016	Class 10: filter review; project discussion (https://canvas.uw.edu/calendar?event_id=916625&include_contexts=course_1075104)	11am to 1pm
Wed Nov 2, 2016	Class 11: feedback filters (https://canvas.uw.edu/calendar?event_id=916615&include_contexts=course_1075104)	11am to 1pm
Sun Nov 6, 2016	Class Prep 6: ch. 6 (https://canvas.uw.edu/courses/1075104/assignments/3331026)	due by 11:59pm

Mon Nov 7, 2016	Class 12: feedback filters (https://canvas.uw.edu/calendar?event_id=916626&include_contexts=course_1075104)	11am to 1pm
	Pre-lab 6 (https://canvas.uw.edu/courses/1075104/assignments/3331034)	due by 1:05pm
	Lab 5 (https://canvas.uw.edu/courses/1075104/assignments/3331043)	due by 11:59pm
Wed Nov 9, 2016	Class 13: the Discrete and Fast Fourier Transforms (https://canvas.uw.edu/calendar?event_id=916614&include_contexts=course_1075104)	11am to 1pm
Mon Nov 14, 2016	Class 14: the Fourier Transform; midterm review (https://canvas.uw.edu/calendar?event_id=916613&include_contexts=course_1075104)	11am to 1pm
	Pre-lab 7 (https://canvas.uw.edu/courses/1075104/assignments/3331032)	due by 1:05pm
	Lab 6 (https://canvas.uw.edu/courses/1075104/assignments/3331044)	due by 11:59pm
Wed Nov 16, 2016	Midterm (https://canvas.uw.edu/courses/1075104/assignments/3331047)	due by 1pm
Thu Nov 17, 2016	Project Interim Report (https://canvas.uw.edu/courses/1075104/assignments/3349673)	due by 11:59pm
Sun Nov 20, 2016	Class Prep 7: ch. 7 (https://canvas.uw.edu/courses/1075104/assignments/3331027)	due by 11:59pm
Mon Nov 21, 2016	Class 15: Fourier transform; spectral analysis (https://canvas.uw.edu/calendar?event_id=916628&include_contexts=course_1075104)	11am to 1pm
Wed Nov 23, 2016	Class 16: compression (https://canvas.uw.edu/calendar?event_id=916629&include_contexts=course_1075104)	11am to 1pm
	Lab 7 (https://canvas.uw.edu/courses/1075104/assignments/3331045)	due by 11:59pm
Mon Nov 28, 2016	Class 17: audio and video compression (https://canvas.uw.edu/calendar?event_id=916630&include_contexts=course_1075104)	11am to 1pm

	Pre-lab 8 (https://canvas.uw.edu/courses/1075104/assignments/3331031)	due by 1:05pm
Wed Nov 30, 2016	Class 18: wrap-up and project presentations (https://canvas.uw.edu/calendar?event_id=919803&include_contexts=course_1075104)	11am to 1pm
Mon Dec 5, 2016	Class 19: project presentations (https://canvas.uw.edu/calendar?event_id=916631&include_contexts=course_1075104)	11am to 1pm
Wed Dec 7, 2016	Class 20: project presentations, cont'd (https://canvas.uw.edu/calendar?event_id=916627&include_contexts=course_1075104)	11am to 1pm
	Project Presentation (https://canvas.uw.edu/courses/1075104/assignments/3349667)	due by 1pm
	Lab 8 (https://canvas.uw.edu/courses/1075104/assignments/3331046)	due by 11:59pm
Fri Dec 9, 2016	Course Evaluation (https://canvas.uw.edu/courses/1075104/assignments/3462029)	due by 11:59pm
Wed Dec 14, 2016	Final Project Report (https://canvas.uw.edu/courses/1075104/assignments/3331038)	due by 11:59pm