

Computing & Software Systems 457: Multimedia and Signal Computing Spring 2010

Basic Course Information

One of the fastest growing application areas for computers is the processing of *multimedia* — sound, images, and video. Multimedia places great demands on processing power, network bandwidth, storage capacity, I/O speed, and software design. In this course, you will learn how multimedia information is captured, represented, processed, communicated, and stored in computers. The specific topics we will cover include: physical properties of multimedia source information (sound, images), human perception of multimedia information, devices for information capture (microphones, cameras), digitization, compression, digital media representation (JPEG, MPEG), digital signal processing (filtering, frequency and time domain techniques), and network communication. By the end of this course, you should 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 (e.g., wireless communication devices) and multimedia computing systems.

Course Objectives The goals of this course are for you to learn:

- What signals are like in the “real” world and how the properties of multimedia signals (sounds, images, video) affect how we perceive them.
- How to use mathematics as a tool to make problem solving *simpler*, for example, converting laborious trigonometric computations to straightforward algebra with polynomials.
- How these 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. You should be well-prepared to work with electrical engineers in the design of more advanced signal processing systems.
- 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.

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 may do some programming, this is *not* a programming course.

Instructor Michael Stiber stiber@u.washington.edu, room UW1-360D, phone (425) 352-5280, office hours Monday evenings (on [Catalyst discussion board](#)) and Wednesdays 2:30–3:30PM (in my office) or by appointment.

Lectures Wednesdays, 3:30-5:35PM, UW1-040.

Textbook Michael Stiber & Bilin Stiber, *Signal Computing: Digital Signals in the Software Domain*, available by [e-reserve](#).

On reserve A hyperlinked PDF version of the course textbook is available via [e-reserve](#). The following books are also on [e-reserve](#) in the library for further reading:

- J. Crowcroft, M. Handley, & I. Wakeman, *Internetworking Multimedia*, Morgan Kaufmann, 1999, chapter 4 (§ 4.1–4.5).
- Donald Hearn & M. Pauline Baker, *Computer Graphics*, Second Edition, Prentice Hall, 1997, chapter 2 (§ 2.1–2.4).
- 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.
- Alistair Moffat and Andrew Turpin, *Compression and Coding Algorithms*, Kluwer Academic Publishers, Boston, 2002.
- Mark Nelson and Jean-Loup Gailly, *The Data Compression Book*, 2nd edition, M&T Books, New York, 1995.
- Ken Pohlman, *The Compact Disc Handbook*, A-R Editions, 1992.
- K.R. Rao & J.J. Hwang, *Techniques & Standards for Image, Video & Audio Coding*, Prentice Hall, 1996, chapters 4 & 5.
- Robert S. Tannenbaum, *Theoretical Foundations of Multimedia*, Computer Science Press, 1998, chapters 1 & 2.
- A. Murat Tekalp, *Digital Video Processing*, Prentice Hall, 1995, chapters 1, 2, 18, 19, 21.
- Ian H. Witten, Alistair Moffat, and Timothy C. Bell, *Managing Gigabytes: Compressing and Indexing Documents and Images*, Morgan Kaufmann, San Francisco, 1999.

Software We will be using [J-DSP](#) for the bulk of our computing laboratories. J-DSP is a Java applet that lets you build signal processing systems by assembling “block diagrams”. The initial laboratory assignment will be an orientation to J-DSP.

Grading 35% laboratories + 30% midterm + 35% final

Because this course is credit/no credit, I will use the following minimum criteria for determining whether you will get credit for this class (however, I’m assuming that everyone will work to get as much out of this class as possible, rather than shooting for the minimum):

- Basic mastery of the majority of course material.
- Satisfactory completion of at least six of the seven labs.
- Active participation in class or in on-line discussion.
- Passing grade (I will announce what grade is passing after the test is graded) on both midterm and final, or a ‘B’-level grade in the final (again, determined by me after-the-fact).

Laboratories You will be completing *laboratories* for the homework portion of this course. For the most part, each laboratory will involve a PDF file describing what you are to do using J-DSP. You are asked to write up a laboratory report and submit it as hard copy on the due date. No particular format is prescribed; it is your responsibility to ensure that your report clearly shows that you have followed the stated procedures (at a minimum), understood the concepts, and unambiguously documents your results. This will almost certainly require you to include screen captures of J-DSP block diagrams, windows, or graphs. Parts of some labs will also include written (i.e., pencil and paper) portions. Because this class will be meeting only once per week, the course will be structured so that we will introduce a subject one week, you will do the lab before the next week’s meeting (consultation with me available on-line), and at the next meeting we will go over the lab to reinforce and clarify concepts before moving on to introducing the next subject and previewing its lab.

Special needs The University of Washington is committed to providing equal opportunity and reasonable accommodation in its services, programs, activities, education and employment for individuals with disabilities. If you believe that you have a disability and would like academic accommodations, please contact Disability Support Services at 425.352.5307, 425.352.5303 TDD, 425.352.3581 FAX, or at dss@uw.edu. DSS will be happy to provide assistance. You will need to provide documentation of your disability as part of the review process.

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.**

Course Outline

Date	Topics	Textbook Reading	Lab
3/31	Signals in the physical world	§ 1.1–1.6	lab 0 preview
4/7	Spectra; Signals in the computer	§1.7, Ch. 2	lab 0 review; lab 1 preview
4/14	Signals in the computer, cont'd	Ch. 2	lab 1 review; lab 2 preview
4/21	Feedforward filters	Ch. 3	lab 2 review; lab 3 preview
4/28	Feedforward filters, cont'd	Ch. 3	lab 3 review; lab 4 preview
5/5	Midterm review	Ch. 1–3	lab 4 review; take-home midterm assigned
5/12	The z-transform and convolution	Ch. 4	midterm review; lab 5 preview
5/19	Feedback filters	Ch. 5	lab 5 review; lab 6 preview
5/26	Spectral analysis	Ch. 6	lab 6 review; lab 7 preview
6/2	Compression; Audio & video coding	Ch. 7, 8	lab 7 review; final preview
6/9	Final		