MAT 320 Syllabus

Semester:	Fall 2018
Course title:	Mathematics of Digital Signal Processing I
Instructor:	Professor Matt Klassen
Email:	mklassen@digipen.edu
Phone:	(425) 895-4423
Office hours:	M-W 1:00-2:30, or by appointment
Course Web Page:	http://azrael.digipen.edu/MAT320
Time/Place:	T,Th 9:00-10:20, in Hopper

WEB PAGES AND MOODLE:

The Moodle page for MAT320 will contain a link to the course web page. The web page is the central repository for all course documents, including homework assignments. Updates to homework will be posted on the web page only. Scores for quizzes, homework, exams, and projects, will be posted through perl scripts on the course web page.

The Moodle page will be primarily used for chat, forums, and for submission of projects.

MATERIALS:

Text: *A Digital Signal Processing Primer*, by Ken Steiglitz. The course is based on this text, lecture material, notes, and homework.

Reference Materials (not required) :

Notes on the Fourier Transform, by Brad Osgood:
(see https://see.stanford.edu/materials/lsoftaee261/book-fall-07.pdf)
Digital Signal Processing, by Oppenhiem and Schafer
The Audio Programming Book, by Boulanger and Lazzarini
Musimathics, Volumes 1 and 2, by Gareth Loy
Digital Filters for Everyone, by Rusty Allred
Music: A Mathematical Offering, by David Benson
Schaum's Outline: Digital Signal Processing, by Monson Hayes
On the Sensations of Tone, by Hermann Helmholtz
Real Sound Synthesis for Interactive Applications, by Perry Cook
Signals, Sound, and Sensation, by William Hartmann
Designing Sound, by Andy Farnell

BACKGROUND MATHEMATICS:

Calculus and Linear Algebra

COURSE DESCRIPTION:

This course explores the mathematical foundations of digital signal processing, with applications to digital audio programming. Topics include: digital signals, sampling and quantization, complex numbers and phasors, complex functions, feedforward filters, feedback filters, frequency response and transfer functions, periodic signals and Fourier series, discrete Fourier transform and fast Fourier transform, comb and string filters, Z-transform and convolution.

COURSE GOALS AND OBJECTIVES:

1) Students will learn some of the basic algorithms in digital signal processing using complex numbers, such as the Discrete and Fast Fourier Transforms, and various filters.

2) Students will become familiar with basic concepts of digital signal processing and will describe these from the mathematical perspective.

3) Students will solidify their knowledge of Linear Algebra and Calculus by using these subjects as tools to solve problems involving vector spaces of complex numbers, continuous functions, and discrete functions and signals.

QUIZZES AND EXAMS:

Quizzes will be given periodically to test comprehension of lecture material. There are no make up quizzes, but I do drop the lowest two quiz scores. The quizzes will last for approximately twenty minutes.

For multiplie choice quizzes and exams, please follow these procedures: Work out the quiz problems and circle your answers on the question sheet. When you are finished, transfer the answers to the answer sheet. Go to a web browser and enter the answers online. Under no circumstances are you allowed to discuss the quiz questions with any other student during the quiz or the data entry process. You should turn in the answer sheet at the front of the room, and keep the question sheet for reference. Your scores will be posted online by your student ID.

There will be a midterm exam given during regular class hours, and a final exam. There are *NO* make up exams unless you have a *compelling and well documented reason* for missing a test.

Calculators are allowed on quizzes and exams.

HOMEWORK ASSIGNMENTS:

Homework will be assigned and posted on the web page and collected weekly. You are responsible for checking the web page and noting the assignments and the due date. You may work on homework together, as well as consult the tutors and the instructor. However, the final work that you turn in must be your own work.

COMPUTATIONAL RESOURCES:

You are encouraged to do linear algebra and other calculations for the homework using a calculator or symbolic package such as SciLab. The symbolic algebra package SciLab is free and open-source, and is similar to MATLAB.

GRADING:

Midterm Exam	20%
Final Exam	20%
Homework	20%
Quiz	20%
Projects	20%

Grades will be determined based on total course percentage. Percentage scores will determine letter grades according to the scale: (in the worst case)

A	$93 - 100$
A-	$90 - 92.9$
B+	$87 - 89.9$
B	$83 - 86.9$
B-	$80 - 82.9$
C+	$77 - 79.9$
C	$73 - 76.9$
C-	$70 - 72.9$
D	$60 - 69.9$
F	< 60

PROJECTS:

The full description of the programming project can be found on the course web page. Submission of projects should be in a zipped folder which contains source and executable and which can be uploaded on the Moodle page.

The programming project is in five parts worth equal weights:

1. I Complex numbers – due Friday 9/28,
2. II Discrete Fourier Transform – due Friday 10/12,
3. III Fast Fourier Transform – due Friday 10/26,
4. IV Low Pass Filter – due Friday 11/9,
5. V Plucked String Filter – due Friday 11/30

ACADEMIC INTEGRITY:

Academic dishonesty in any form will not be tolerated in this course. Cheating, copying, plagiarizing, or any other form of academic dishonesty (including doing someone elses individual assignments) will result in, at the extreme minimum, a zero on the assignment in question, and could result in a failing grade in the course or even expulsion from DigiPen.

All students are asked to help in promoting a culture of academic integrity by discouraging cheating in all forms.

DISABILITY STUDENT SERVICES:

If students have disabilities and will need formal accommodations in order to fully participate or effectively demonstrate learning in this class, they should contact the Disability Support Services Office at (425)629-5015 or dss[at]digipen[dot]edu. The DSS Office welcomes the opportunity to meet with students to discuss how the accommodations will be implemented. Also, if you may need assistance in the event of an evacuation, please let the instructor know.

TENTATIVE WEEKLY TOPICS:

Week	Dates	Topics
1	Sep 4 - Sep 7	Introduction to Complex Numbers: rectangular and polar forms, norm, conjugate, complex vectors, complex dot product.
2	Sep 10 - 14	Phasors, complex functions, linear algebra review: linear independence, bases, discrete Fourier Transform.
3	Sep 17 - 21	Strings, Pipes, Wave Equation; Frequency Ratios. Introduction to Fast Fourier Transform: FFT.
4	Sep 24 - 28	Sampling and Quantization, Aliasing, Decibels. Bit reversal for FFT implementation.
5	Oct 1 - 5	Feedforward Filters: Delay and Transfer function.
6	Oct 8 - 12	Feedforward Filters: stability, phase, inverse comb
7	Oct 15 - 19	Feedback filters: poles and zeros
8	Oct 22 - 26	Feedback filters: resonance, filter design
9	Oct 29 - Nov 2	Periodic sounds, Fourier series and transforms. Zero crossings, periodicity and nonlinear wave equation.
10	Nov 5 - 9	Intro to Comb and string filters
11	Nov 13 - 16	Resonance and tuning, first-order allpass filter.
12	Nov 19 - 23	z-transform and convolution.
13	Nov 26 - 30	orthogonality, impulse and step, inverse z-transform
14	Dec 3 - 7	Continuous Fourier Transform, Summary of Transforms and Inverses, Time-Frequency Correspondences
15	Dec 10 - 14	Final Exams