

MAT 321 Syllabus

Semester:	Spring 2021
Course title:	Mathematics of Digital Signal Processing II
Instructor:	Professor Matt Klassen
Email:	mklassen@digipen.edu
Phone:	(425) 895-4423
Office hours:	T,W 2:00-3:00, or by appointment
Course Web Page:	http://azrael.digipen.edu/MAT321
Time/Place:	T,Th 9:00-10:20, online in Teams

WEB PAGES AND MOODLE:

The Moodle page for MAT321 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.

The Teams channel will be used for lectures. Students may record lectures and review them in Teams.

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) :

Digital Signal Processing, by Oppenheim and Schaffer

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 continues to explore the mathematical foundations of digital signal processing, with applications to digital audio programming. Topics include: Review of digital signals, Z-transforms and convolution, filter types, applications of fast Fourier transform, switching signals on and off, windowing, spectrograms, aliasing, digital to analog conversion, Nyquist Theorem, filter design, Butterworth filters, reverb, and the phase vocoder.

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 multiple 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.

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

ACADEMIC INTEGRITY:

Academic dishonesty, or cheating, occurs when a student represents someone else's work as their own, or assists another student in doing so. This can happen on exams, quizzes, homework, or projects. Academic dishonesty also may occur when a student uses any prohibited reference or equipment in the completion of a task. For example, the use of a calculator, notes, books or the internet when it is prohibited. Plagiarism is a common form of academic dishonesty. This can take the form of copying and pasting excerpts from the web, and representing them as original work. The type and severity of any occurrence, as well as the legitimacy of any claim of academic dishonesty, will be judged by the instructor and the disciplinary committee. All students are asked to help in promoting a culture of academic integrity by discouraging cheating in all forms.

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.

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.

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.

DISABLED STUDENT SERVICES:

Students with physical, psychological or learning disabilities that affect their ability to perform major life activities associated with this class may be eligible for reasonable accommodations under the Americans with Disabilities Act. If you have a documented disability please contact the Disability Support Services office to arrange for accommodations for this class.

GRADUATE STUDENTS:

Graduate students will be required to do a class presentation or report which will be factored in as part of their homework grade. The subject matter will involve an in depth analysis of a particular problem, or an application, and will require some synthesis of current work and contributions in the field. This will form part of the graduate student exposure to research methods in course work.

TENTATIVE WEEKLY TOPICS:

Week	Dates	Topics
1	Jan 4 - 8	time/frequency domains, discrete-time phasors
2	Jan 11 - 15	Z-transform and convolution
3	Jan 18 - 22	inverse Z-transform, stability
4	Jan 25 - Jan 29	Applications of the FFT, switching signals on and off
5	Feb 1 - 5	Windowing, spectrograms
6	Feb 8 - 12	Summary of transforms, time-frequency correspondences
7	Feb 15 - 19	Periodization and the continuous Fourier transform Midterm Exam: Thursday, Feb.18
8	Feb 22 - Feb 26	Fourier transform of rect, sinc, and Gaussian
9	Mar 1 - 5	Spring Break
10	Mar 8 - 12	Convolution integral for continuous functions
	Mar 15 - 19	Schwartz functions and Distributions as limits Tempered distributions as linear functionals
11	Mar 22 - 26	Shift and derivative properties for Fourier transform Sampling and Interpolation: from continuous to discrete
12	Mar 29 - Apr 2	Nyquist theorem, digital to analog conversion
13	Apr 5 - 9	reverb, oversampling
14	Apr 12 - 16	filter design and implementation
15	Apr 19 - 23	Final Exams