ECE 2026 – Introduction to digital signal processing – Spring 2025	**Schedule**: Monday (3:30 – 4:20 pm, Brown room) and Wednesday (2:00 – 4:45 pm, Brown room / Computer Lab)
Instructor: Prof. Jean Paul Salvestrini, Office 204	email: jean-paul.salvestrini@georgiatech-metz.fr
Office Hours: On appointment (pre-arranged preferably by email) or just after the class.	Cell (emergencies only!) +33(0)6 45 53 46 41

Course Description

Introduction to signal processing for discrete-time systems. Sampling Theorem. Filtering. Frequency response. Discrete-Time Fourier Transform. Discrete Fourier Transform. Z Transform. The course emphasizes the theory, but laboratory exercises will familiarize students with computer-based signal processing. Please note that this is NOT a computing course and I cannot help you with purely computing questions, including but not limited to going over code and installing MATLAB.

Prerequisites

MATH 1502/1512 or MATH 15X2 and MATH 1522 [all min C] and CS 1371 [min C] or CS 1171*

Course Outcomes

Upon successful completion of this course, students should be able to:

(1) Express signal processing systems in mathematical form;
(2) Write MATLAB code describing a basic signal-processing system;
(3) Analyze signals in terms of their frequency content;
(4) Describe system behavior in terms of frequency content;
(5) Analyze linear system behavior in terms of Fourier transform and frequency response;
(6) Analyze mixed analog-digital systems with sampling operations and digital filters;
(7) Utilize the z-transform to analyze discrete-time systems in terms of poles and zeroes;
(8) Use complex exponential notation to describe signals and systems;
(9) Describe how signal processing is used in applications (e.g., audio and digital image processing).

Texts

- *DSP First*, 2nd Edition by McClellan, Schafer & Yoder, Prentice-Hall, ISBN-10: 0136019250, ISBN-13: 9780136019251
- Also see: dspfirst.gatech.edu

MATLAB

Student version: http://matlab.gatech.edu/ . Students who use their own laptop MUST install MATLAB prior to the start of the course. Desk-top machines with MATLAB installed are available at GTL. The instructor will not be responsible for troubleshooting software problems.

Class Attendance

Though I do not keep attendance, your attendance is expected and is a critical part of performing well in the course. In addition, if you miss class, you might miss laboratory work that must be or is best done in class (see below). Participation in lectures will be an important way to stay engaged with the course. (Of course, this has to be supplemented by working homework problems, reading the text and other materials, and other practice.) Class size is usually small. This allows for splitting class into teams and solving problems.

As mentioned above, class attendance is expected. Students who miss class might also miss important activities related to labs that can impact grades. Institute policy on absences for illness or personal

emergencies may be found at: http://www.catalog.gatech.edu/policies/student-absence-regulations/ . For illnesses or personal emergencies, students are responsible for providing the documentation to the representative at GTE of the Dean of Students (Prof. Paul Voss) where it will be treated and handled confidentially. If you are comfortable with also presenting the documentation to me, please feel free to do so.

If you have an institute (GTE) approved activity that will cause you to miss class, then you must provide me with documentation at least two weeks before the activity.

Office of Disability Services:
If you are a student registered with the Office of Disability Services (ODS), please make sure the appropriate forms and paperwork are completed and I am notified by ODS within the first week of classes. The instructors will abide by all accommodations required by ODS. It is the responsibility of the student to properly arrange test accommodations for each exam with ODS in sufficient time to guarantee space for exam administration. ALL exam accommodations must be handled through ODS. If the student does not register accommodations with ODS for the taking of an exam, then they will have to take the exam at the normally scheduled times without any additional accommodation unless the instructor is given specific directive from ODS on the students behalf due to a mitigating circumstance.

Lectures:
Lectures (about 20) are held twice a week as per the GTE class schedule unless otherwise announced and slides at the class website on Canvas. The purposes of the lectures are to inform students of the broad view on topics that are being covered each week. Ideally, the main lectures should motivate each topic and introduce the major components involved in developing a deeper understanding of the course material.

Original lecture notes are posted at dspfirst.gatech.edu. Also see this website for other materials (practice problems, etc.). My own adapted lecture notes are posted on Canvas. Homeworks and Labworks are also posted on Canvas.

Laboratory (held in part during Wednesday classes):
Students are encouraged to work in groups of 2-4. The laboratory explores hands-on applications of the course concepts using MATLAB. It is a critical component of the course. I will not "teach" or provide this part of the course; you should regard it as self-taught with or without collaboration. This is something you will have to work on yourself and with your peers.

Students should install MATLAB on their own laptop prior to the first day of class, though it is installed on the machines in the computer room at GTE. The software is covered by the GT site license and can be accessed at http://software.oit.gatech.edu (Links to an external site.) . Note that you may need to use the GT VPN to download software once you are at GTL; therefore, I suggest that you download and install MATLAB *prior* to coming to GTE.

Note that I provide MATLAB Amnesty Days at the end of the term (weeks 47 and 48). Students who have turned in previous MATLAB reports can use the class period these days to correct errors in those reports and resubmit them for regrading. There will be no lecture these days.

Bring your laptop to classes the days of labs. For those of you without laptops, you may use the desktop machines in the computer room. If you collaborate on the labs with other students, you can share a single laptop in class. But all students should be certain they understand the code they write collaboratively and can run it on their own.

There will be approximately twelve written lab reports, including corresponding codes and plots, compiled into a single pdf file. Each student must turn in his/her own report listing the other students' names with whom he/she has substantially worked. Late assignments will not be accepted. Assignments will be turned in on Canvas. Grading will be on a 0-4 point scale:

4=100 % -- substantially complete and correct, thoroughly carried out
3=90 % -- mostly complete and correct, some deficiencies

2=80 % -- basic issues correct, though substantial deficiencies
1=70 % -- significant attempt, but serious deficiencies
0=0 % -- no significant attempt

Homework

10 written homework will be assigned approximately weekly. Homework will not be graded. Solutions will be posted within approximately one week of the suggested completion date. It is important to do the homework diligently and to make sure you master the problems as this is the way you will learn the course material. In addition, quiz and final-exam problems will be of a similar nature to homework problems.

Quizzes

There will be three in-class quizzes as given tentatively in the schedule below. The quizzes will be heavily drawn from problems given in the homeworks. **Thus, mastery of homework problems is likely to translate into high quiz** (and exam!) **grades**.

Each quiz will concentrate on material covered between specified cutoffs (TBA)—typically from the cutoff from the previous quiz, but will nonetheless be comprehensive. That is, while the emphasis will be as described above, knowledge of material that came before in the course will be required to do well on the quizzes and there may be specific questions or parts of questions that focus on earlier work.

Failure to take a quiz (see above) may result in a grade of zero unless you present **written documentation** that you have a valid excuse and that I accept the excuse. If you have any questions, please consult me AND Prof. Paul Voss. Unless the excuse is related to an obviously unforeseen emergency, this documentation must be presented one week prior to the quiz or a grade of zero may result. Specifically, travel will not constitute a valid excuse.

Quizzes must be taken on the dates indicated. Failure to take a quiz at the indicated time will result in a grade of zero. Quiz times might be changed only for the entire class under exceptional circumstances, provided no student objects, but not for individual students. Please consult the syllabi for all your courses immediately so that you can budget your study time.

Final Exam

The final exam is cumulative and comprehensive.

Grading

The course grade will be computed according to the following weights:
Labs: 10% (Written assignments, see lab policy above)
Quiz 1: 20%
Quiz 2: 20%
Quiz 3: 20%
Final Exam: 30%

See course calendar for lab and quiz dates. Final exam will be given in the official timeslot for the course (TBD).

We will follow the basic grading scale where: A=90-100; B=80-89; C=70-79; D=60-69; F=0-59. This means raw grades directly translate to letter grades for the course; however, the boundaries may be modified at the end of the semester based on the overall class performance. It is impossible to determine what the exact "cutoffs" will be for each grade but you can be assured that your assigned grade will never be lower than that of the grading scale described above based on your final class average. You are therefore responsible to keep track of your grades and retain copies of all graded materials.

Academic Conduct

As noted above, you are free to work with other students on problem sets. You must work strictly alone on quizzes and the final exam. On quizzes and the final exam, unless I expressly grant exceptions later in the course, no notes, books, calculators, electronic devices, or any other aids will be permitted. I will supply a formula sheet that will be made available to you prior to the quizzes and final exam.

Students in this class are expected to abide by the Georgia Tech Honor Code and avoid any instance of academic misconduct, including but not limited to:

- Possessing, using, or exchanging improperly acquired oral or written information in the preparation of a quiz or the final project.
- Submission of material that is substantially identical to that created or published by another individual, except as noted below.
- False claims of performance or work that has been submitted by the student.

Be sure to report observed instances of violations of the Honor Code! Remember, the Honor Code is about honor. Apart from devaluing your own work, the work of your classmates, and the Georgia Tech degree, Violations of the Honor Code carry significant penalties, here at Tech, and for life. Do you want to be labeled as having cheated? The trustworthiness of engineering and science (as well as the reliability and safety of products!) relies on the basic honesty of engineers and scientists. Students may work in groups on the final project as will be discussed in a future handout, though each must student make a good-faith effort to contribute to the group. Each student must also write up and turn in his/her work to integrate the knowledge. Please turn off notifications on cell phones, etc. Some students may choose to use computers for note taking during class; however, if I perceive that they are a distraction, I might ask that they be put away. See the Georgia Tech Honor Code for further information or ask instructor.

Communications

You are responsible for all announcements (which may include information about the homework, quizzes, and the final exam) made in class. Quizzes will likely strongly reflect material covered in class. If you miss class, do not ask me what was covered. Handouts may also be distributed from time to time in class; it is your responsibility to obtain information from classmates if you are not present when information is given or materials are distributed, though materials are likely to be posted on Canvas. I may also email the class various information.

Notes, problem sets, solutions, and various other useful information will be posted on Canvas.
The best way to contact me is via email, briefly immediately before or after class or by appointment.

Getting Help

The material in this course builds on earlier material, so it is very important to not get behind. Be sure to contact me (see above) or use other resources that are available. As noted above, email questions or arrange for an appointment. While some resources may be more difficult to access at GTE than in Atlanta, class sizes tend to be small, so use this to your advantage!

Student Collaboration:

Students are encouraged to study together for homework, lab reports and exams to openly discuss course topics. However, each assignment that is turned in must reflect the work of each individual student. In other words, you may work with other students on labs and homeworks, but you must write up the work yourself. I also require that in case you have worked substantially with others, you list the names of those students on the assignments you turn in. No copying of work from other students in (or out) of this class is allowed and such activity would represent a violation of the Academic Honor Code. If you are not certain of the nature of a student collaboration you are involved in, please feel free to contact me.

No collaboration is permitted on quizzes or exams. Unless you receive specific instructions, calculators, any printed, written, or online materials including but not limited to notes, books, formula sheets, or consultation with others are not permitted.

Student Commitment:

As the student, you agree to commit your time and energy to learn the material by completing all assignments in a timely manner, attending all class sessions, and seeking help when you require it.
All of the above is tentative and subject to change. The final syllabus together with a schedule will be issued no later than the end of the first week of class. In addition, suggested homework completion dates and lecture numbers covered are likely to shift somewhat; I often fall somewhat behind what is posted on the calendar.

Course calendar:

It is unlikely that the listed topics and homework assignments will match up exactly on the listed dates. This is just a rough estimate of how the material will flow and homework coverage to give you a sense of where we are headed. However, the quiz dates are unlikely to be changed.

Week #	Class #	Topic	Reading assignment	*HW / Lab assign.*
2	1	Sinusoids ; Phase and time-shift ; Delay and attenuation	Chap. 1: Introduction Chap. 2, sections 2.1 to 2.5 Appendix A & B	***Lab0:*** *P1 (Home)* ***HW1****: Ex. 2.8, 2.40, 2.41, 2.42, 2.45, 2.78*
	2	Complex Exponential & Complex Numbers ; Phasor Addition Theorem	Chap. 2, sections 2.1 to 2.6 Appendix A & B	***Lab1:*** *P2 (Home)*
3	3	Spectrum representation ; Operations on the spectrum ; Periodic signals, Harmonics and time-varying sinusoids ;	Chap. 3, sections 3.1 to 3.3 & 3.6 to 3.7 Appendix A	***Lab2****: P4 (Home)* ***HW2****: 3.8, 3.16, 3.20, 3.22, 3.42, 3.47*
	4	Fourier Analysis ; Fourier Series examples: common periodic signals ; Fourier series and spectrum	Chap. 3, sections 3.4 to 3.5 Appendix C,	***Lab3****: S8*
4	5	Sampling and aliasing	Chap. 4, sections 4.1 to 4.4	***HW3****: 4.7, 4.40, 4.41, 4.42, 4.45, 4.48*
	6	**Quiz #1**	**22nd of January**	
5	7	Finite Impulse Response (FIR) filtering	Chap. 5, sections 5.1 to 5.4	***HW4****: 5.15, 5.16, 5.17, 5.20, 5.36,*
	8	Linearity and time-invariance ; Convolution	Chap. 5, sections 5.4 to 5.8	***Lab4****: P9*
6	9	Frequency response of FIR filters	Chap. 6, sections 6.1 to 6.5	***HW5****: 6.1, 6.5, 6.6, 6.25,*
	10	Digital filtering of analog signals: the Discrete Time Fourier Transform	Chap. 6, sections 6.6 to 6.8	***Lab5****: P11*
7	11	Discrete-Time Fourier Transform	Chap. 7, section 7.1	***HW6:*** *6.27, 7.1, 7.3, 7.5, 7.6*
	12	DTFT properties	Chap. 7, sections 7.2 to 7.3	***Lab6****: S6*
8	13	FIR filter design via windowing	Chap. 7, sections 7.3 to 7.4	
	14	Discrete Fourier Transform	Chap. 8, sections 8.1, 8.2 and 8.4	***Lab7****: S8*
9	15	Discrete Fourier Series and windowing	Chapter 8, Sections 8-3, 8-5 & 8-6	***HW7:*** *8.1, 8.2, 8.3, 8.6*
	16	Spectrogram: spectral analysis via DFT and DTFT	Chapter 8, Sections 8-6 & 8-7 Other Reading: FFT: Chapter 8, Sect. 8-8	***Lab9****: P13*
11	17	Z Transforms: an introduction	Chapter 9, Sects 9-1 through 9-5	
	18	**Quiz #2**	**12th of March**	
12	19	Zeros of H(z) and the frequency domain	Chapter 9, Sects. 9-5 & 9-6 Other Reading: Examples: Chapter 9, Sects. 9-7 & 9-8, ZEROS and POLES, Practical Bandpass Filters	***HW8:*** *9.1, 9.4, 9.6, 9.9*
	20	IIR filters: feedback and H(z)	Chapter 10, Sects. 10-1, 10-2, & 10-3 Other Reading: Optional: Ch. 10, Sect 10-4 FILTER STRUCTURES	***Lab10****: P16*

13	21	Frequency response, H(z), poles and zeros for IIR and FIR systems	Chapter 9, Sects. 9-5 and 9-6 Chapter 10, Sects. 10-5 and 10-7	***HW9:*** *10.8, 10.15, 10.17, 10.24, 10.25*
	22	Time-domain responses for IIR systems	Chapter 10, Sects. 10-9, 10-10, & 10-11 Partial Fraction Expansion	***Lab11****: S9*
14	23	Second order IIR filters: 3 domains	Chapter 10, Sects. 10-11 and 10-12 Other Reading: Example of IIR LPF in Sect. 10-13 POLES & ZEROS, Frequency Response, Impulse Response	***HW10:*** *10.27, 10.29, 10.32, 10.33*
15	24	**Quiz #3**	**9th of April**	
	25	Computer Lab, office hours & other		
16	26	Computer Lab, office hours & other		
	27	Computer Lab, office hours & other		
17		Finals		
18		**Finals**	***TBD***	