Foundations of Digital Signal Processing

EEL 4750 / EEE 5502
Class Periods: M, W, F | Period 3 (9:35 AM – 10:25 AM)
Class Location: NEB 100
Academic Term: Fall 2019
Website: http://smartdata.ece.ufl.edu/eee5502/

Instructor
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Supervised Teacher
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Teaching Assistants
Please contact through the Canvas website
- Name: TBA,   Office: TBA,   E-mail: TBA   Office Hours: TBA
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Course Description
This course covers topics related to the foundations of digital signal processing. After completing this course, students should understand the essential properties of discrete-time signals and systems; understand the sampling and reconstruction of signals; be able to perform transform analysis of digital signals and systems, and apply filter design techniques; as well as understand the fundamental principles of multi-rate signal processing.

Course Pre-Requisites / Co-Requisites
Prerequisite: EEL 3135 (Introduction to Signals and Systems) or equivalent

Course Objectives
At the conclusion of this course, you should be able to:
- Apply discrete-time systems to discrete-time signals
- Explain aliasing caused by under-sampling data
- Apply convolution and correlation to modify and locate signals
- Create a Fast Fourier transform algorithm
- Analyze data with the short-time Fourier transform / spectrogram
- Design FIR & IIR filters for modifying time-domain signals
- Analyze data with a multi-channel filter bank
- Apply power spectrum estimation to improve time-frequency filtering and analysis

Recommended Materials
- Digital Signal Processing, 4th edition
  - Authors: John G. Proakis and Dimitris K. Manolakis
  - Publisher: Prentice Hall, 2006
  - ISBN: 0131873741
- EEL 4750/EEE 5502 Course notes
  - Author: Joel B. Harley

Recommended Software
- MATLAB

Course Schedule

Date			Lecture	Reading	Problems	Code Prob.
Wed	Aug	21	**No Class**	Ch. 1		
Wed	Aug	21	Motivation, policies, DSP	Ch. 1		
Fri	Aug	23	Continuous and Discrete-Time Signals	Ch. 1,2		
Mon	Aug	26	Continuous and Discrete-Time Systems	Ch. 2		
Wed	Aug	28	Continuous-Time Convolution	Ch. 2,4	HW 01	code 01
Fri	Aug	30	Discrete-Time Convolution	Ch. 2		
Mon	Sep	02	Continuous-Time Fourier Transforms	Ch. 4,5		
Wed	Sep	04	Sampling	Ch. 6	HW 02	
Fri	Sep	06	Reconstruction	Ch. 6		
Mon	Sep	09	Aliasing	Ch. 6		
Wed	Sep	11	The Discrete-Time Fourier Transform (DTFT)	Ch. 4,5	HW 03	code 02
Fri	Sep	13	The Z-Transform	Ch. 3		
Mon	Sep	16	The Discrete Fourier Transform (DFT)	Ch. 4,5,7		
Wed	Sep	18	Review	--	HW 04	
Fri	Sep	20	**Exam 1**	--		
Mon	Sep	23	Magnitude Responses	Ch. 4,5,7		
Wed	Sep	25	Phase Responses	Ch. 4,5,7		code 03
Fri	Sep	27	Desirable Filter Properties	Ch. 4,5,7		
Mon	Sep	30	Pole / Zero Filter Design	Ch. 10		
Wed	Oct	02	Designing FIR Filters	Ch. 10	HW 05	
Fri	Oct	04	Designing IIR Filters	Ch. 10		
Mon	Oct	07	Implementing FIR Filters	Ch. 9		
Wed	Oct	09	Implementing IIR Filters	Ch. 9	HW 06	code 04
Fri	Oct	11	Lattice Filters	Ch. 9,10		
Mon	Oct	14	Downsampling	Ch. 11		
Wed	Oct	16	Upsampling	Ch. 11	HW 07	
Fri	Oct	18	Resampling	Ch. 11		
Mon	Oct	21	Multi-rate Properties	Ch. 11		
Wed	Oct	23	Review	--	HW 08	
Fri	Oct	25	**Exam 2**	--		
Mon	Oct	28	Introduction to Filter Banks	--		
Wed	Oct	30	Two-Channel Filter Banks	Ch. 11		code 05
Fri	Nov	01	Orthogonal Filter Banks	Ch. 11		
Mon	Nov	04	Localization and Uncertainty	Ch. 11		
Wed	Nov	06	Multi-Channel Filter Banks	Ch. 11	HW 09	
Fri	Nov	08	Time-Frequency Analysis with Filter Banks	Ch. 11		
Mon	Nov	11	Two-Channel Polyphase Filters	--		
Wed	Nov	13	Multi-Channel Polyphase Filters	--	HW 10	code 06
Fri	Nov	15	Fast Fourier Transform with Filter Banks	--		
Mon	Nov	18	Wavelet Filter Banks	--		
Wed	Nov	20	The Discrete Wavelet Transform	--	HW 11	
Fri	Nov	22	Wavelet Packets	--		
Mon	Nov	25	Filter Bank Compression	--		

Wed	Nov	27	**Thanksgiving Break**	--		
Fri	Nov	29	**Thanksgiving Break**	--		
Mon	Dec	02	Review	--		
Wed	Dec	04	Exam 3	--	HW 12	code 07
Fri	Dec	06	**No Class**	--		
Mon	Dec	09	**Final Exam** (3:00 PM - 5:00 PM)	--		

Attendance and Participation Policies

Attendance & Participation:
While attendance is not graded, lectures will include regular homework help and in-class discussions and demonstrations on the subject material. While participation is not graded, it is an integral part of each class that can help you learn the material.

Slack Page:
We have a Slack page for the course: https://uf-eee5502-SP2019.slack.com/. This is an *optional* resource for students to discuss the course amongst each other and occasionally with the Professor and TAs. This resource is intended to supplement office hours and student interactions. **No official communication / submission happens over Slack.** No assignments submissions will be accepted over Slack.

Evaluation Methods and Criteria
The following section discusses the policies for each of the graded assessments in this course. You should look here first for answers to any general, course-related inquiries.

Homework (11 in total)
    When: Assigned roughly once a week (see course schedule on website).
    What: Analytical problems that can be solved by hand.
    Why: Homework is intended to guide you through course material and present you with questions that will require time to think about and complete (unlike quiz or exam questions). Homework assignments are not meant to be completed in a single day.
    Grading: Homework is graded on a scale from 0 to 3. The meaning of each grade is:
        3.0: > 75% correct   2.5: 65% - 75% correct
        2.0: 55% - 65% correct   1.5: 45% - 55% correct
        1.0: 35% - 45% correct   0.5: 25% - 35% correct
        0.0: 00% - 25% correct
    Late policy: Late assignments will not be eligible for $(0.5)x$ points, where x is the number of weekdays late, for up to 2 weekdays. For example, if you receive a 2.5 and submit the assignment 2 weekdays late, the final grade will be a 2.5 - 1 = 1.5. After 2 weekdays, the homework is assigned a 0.
    Submission: Homework will be submitted on canvas before midnight (11:59 PM) on the due date. Please ensure that your submission is readable.

Coding Problems (7 in total)
    When: Occur roughly once every two weeks (see course schedule at the end of the syllabus).
    What: One to three MATLAB (maybe python) problems to complete
    Why: These problems are intended to give you more hands-on, practical experience with digital signal processing and how it is used to solve various engineering problems
    Grading: Coding problems are graded on a 20-point scale. Of the 7 assignments, only the highest scoring 6 will count toward the final grade. Unreadable answers will be considered incorrect.
    Late policy: Late assignments will not be eligible for $2x$ points, where x is the number of weekdays late, for up to 10 weekdays.

Submission: Coding solutions will be submitted on canvas before midnight (11:59 PM) on the due date. Please ensure that your submission is can be run without any additional materials.

Exams (3 in total)

When: There are three non-cumulative exams covering each part of the course and one cumulative final exam.
What: Questions will be similar to homework but generally a little shorter and require less time to think
Why: Exams are an opportunity to show what you know about signals and systems.
Cheat sheets for Exam 1 & 2 & 3: _one_ double-sided 8.5 by 11 inches (or smaller) cheat sheet allowed.
Cheat sheets for Final exam: _three_ double-sided 8.5 by 11 inches (or smaller) cheat sheets allowed.
Grading: Exams are graded on a 100-percentage scale.
Makeup exams: Each part of the final exam acts as a re-take or make-up exam. If you perform poorly on an exam, you will have the opportunity to take one or more final exam parts to replace your grade(s). You will receive the highest grade from each midterm/final part pair.

Evaluation of Grades

Assignment	Percentage of Final Grade (EEL 4750)	Percentage of Final Grade (EEE 5502)
Homework Sets (best 10 out of 11)	20%	20%
Code Problems (best 6 out of 7)	20%	20%
Midterm Exam 1	20%	20%
Midterm Exam 2	20%	20%
Midterm Exam 3	20%	20%
Final Exam	See section on exams	See section on exams
	100%	100%

Grading Policy

Percent	Grade	Grade Points
93.3 - 100.0	A	4.00
90.0 - 93.3	A-	3.67
86.6 – 90.0	B+	3.33
83.3 – 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.6 - 80.0	C+	2.33
73.3 – 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.6 - 70.0	D+	1.33
63.3 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
00.0 – 60.0	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Course & University Policies

Modifying Syllabus by Class Vote

When: If you and/or other students believe the course would be improved by a change in the syllabus and I agree that it would be a reasonable change. **What:** The proposed change will be put to an anonymous vote with the entire class. If the majority of the class agrees to this change, it becomes part of the syllabus. **Why:** In previous years, changes to the syllabus have been necessary do to unforeseen consequences of certain policies. The class vote ensures the entire class agrees with the change.

Collaboration
Healthy collaboration: To solve homework assignments, healthy discussion and collaboration amongst classmates is encouraged. Healthy collaboration includes:
- Discussing and explaining general course material
- Discussing assignments for better understanding
- Providing assistance for general programming and debugging issues

If another student contributes substantially to your understanding of a problem, you should \emph{cite} this student to let myself and the teaching assistants be aware of your similar interpretations of a problem. You will not be judged negatively for citing another student.

Cheating and plagiarism: While collaboration is encouraged, you are expected to \emph{submit your own work}. Submitting work completed by another student is considered plagiarism and will be dealt with according to university policy. In general, if you do not fully understand your solution, the work is not your own. Examples of plagiarism or cheating include:
- Copying (or allowing someone to copy), even partially, an assignment solution or program from the course
- Submitting material, particularly code, using material taken from another source without proper a citation
- Obtaining solutions to assignments or exams through inappropriate means

Note that I may elect to use a plagiarism detection service in this course, in which case you will be required to submit your work to such a service as part of your assignment.

Consequences: If you are suspected of dishonest academic activity, I will invite you to discuss it further in private. Academic dishonesty will likely result in a grade reduction, with severity depending on the nature of the dishonest activity. I am obligated to report on academic misconduct with a letter to the department, college, and/or university leadership. Repeat offences will be treated with significantly greater severity.

Students Requiring Accommodations
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation
Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu/evals. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

• Your academic advisor or Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@ufl.edu

Sexual Discrimination, Harassment, Assault, or Violence: If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Campus Resources:

Health and Wellness

> **U Matter, We Care:**
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> If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.
>
> **Counseling and Wellness Center:** http://www.counseling.ufl.edu/cwc, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.
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> **Sexual Assault Recovery Services (SARS)**
> Student Health Care Center, 392-1161.
>
> **University Police Department** at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

> **E-learning technical support**, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.
>
> **Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.ufl.edu/.
>
> **Library Support**, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.
>
> **Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.
>
> **Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.
>
> **Student Complaints Campus***:* https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.
>
> **On-Line Students Complaints***:* http://www.distance.ufl.edu/student-complaint-process.