

EE 422G (Sections 01 02)

Signals & Systems Laboratory, Fall 2015

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Texts:

EE 422G Lab Notes and same text as used in EE421G

Expected Student Learning Outcomes

Students successfully completing this course are be able to:

1. Characterize random signals with correlation and probability density functions
2. Analyze discrete-time signals with the (discrete) Fast Fourier transform.
3. Design FIR and IIR filters based on signal and noise specifications.
4. Characterize system dynamics using impulse responses, transfer functions, and state-variable representations.
5. Simulate signals and systems using modern computer software packages
6. Design experiments to estimate signal and system model parameters from input and/or output data.

Course Summary

Lectures review material from EE412G. New topics include state variables representation and applications of random variables. Laboratory exercises provide opportunities for applying signal and system concepts to solve problems using modern engineering methods. Topics include noise models, filter design, modulation techniques, sampling, discrete Fourier Transforms, state variable models, and feedback design with an emphasis on using computer software for analysis and simulation.

Prerequisites

EE 421G and MA320. Students taking EE 422G must be able to: **apply** convolution and Fourier methods to determine the output of linear time-invariant systems; **analyze** continuous-time and discrete-time systems with appropriate transforms; **characterize** input-output relationships of linear time-invariant discrete-time systems using impulse response and transfer function representations; **model** signals with random variations using probability distribution functions. Also it is helpful to have a background in matrix algebra and experience with programming languages such as Matlab / C++.

Grading Undergraduate:

Pre-lab assignments (9)	27 %
Lab Reports/Demonstrations (10)	52 %
Laboratory Presence	9 %
Final Project	12 %

Grading Graduate:

Pre-lab assignments (9)	27 %
Lab Reports (10)	48 %
Laboratory Exercise Design	16 %
Laboratory Presence	9 %

Undergraduate Students: Grades will be assigned using a 10-point scale (A: 90% or above, B: 80% or above, C: 70% or above, D: 60% or above, E: below 60%).

Graduate Students: Grades will be assigned using a 10-point scale (A: 90% or above, B: 80% or above, C: 70% or above, E: below 70%)

Laboratory Reports/Demos: Each laboratory assignment is made up of two parts; the pre-lab (analysis and programming) and the corresponding lab exercise (report or demonstration). The pre-lab is due at the beginning of class and EVERYONE hands in a prelab assignment. The lab report is due at the beginning of the next laboratory section meeting, or if a demonstration is required, that must be performed at the end of the current laboratory session. Late reports and pre-labs will be accepted with a 0.25 point per day penalty. If the demo is performed at a later time (other than the end of the lab period), this will result in a reduction of 20% from the final grade. You may work in groups of up to 3 students in the laboratory; where each group turns in individual pre-lab assignments and a single lab report/demo for the group. The report is graded on organization, completeness, clarity, and accuracy, while demos are graded on functionality and ability to answer questions. All lab reports must be prepared in a word processor and printed out. Programs written for the laboratory exercises must be commented and placed in an appendix of the lab report. Programs written for demos may be inspected by the instructor or TA, so they should also be organized and commented so they can be used in explaining what was done. In the case of LabVIEW and Simulink programs, a screen shot of the block diagram (with descriptive labels), panels and plots, can be taken and included as figures in the lab report. (2 to 6 points per assignment depending to level of required work)

Pre-Lab Assignments: Pre-lab assignments typically involve an analysis/synthesis of systems used in the experiment, or the development of a program template to be used in the lab exercises. The responses to the pre-lab questions must be handed in at the beginning of class by everyone in the group. You should make a copy for reference during the lab and report write-up. The better prepared each lab member is from reading the background, looking up references, and doing the pre-lab assignment, the more efficient the time in the lab is used. **You must finish the experiment within the 3 hour time period.** The pre-lab assignments can be handwritten, but must be legible and organized. The pre-lab is graded on completeness, clarity, and accuracy. (3 points per assignment)

Laboratory Notebook: The use of laboratory notebooks to record the work done to prepare for each lab and take notes during the lab time is recommended. Many ideas and key pieces of information arise during lectures, readings, and laboratory experiments, and it is necessary to keep track of these. The engineering/laboratory notebook is a standard way to keep track of these ideas for use in industrial operations, patent applications, and FDA approval processes. The notebook is especially useful for collecting information for the lab reports, and providing something to stare at when you encounter a problem or unexpected result in the lab. Recommended notebooks, such as those used in senior design, are the 48-page or 96-page student laboratory notebooks sold by Eureka <http://www.eurekalabbook.com/Studentnote.html> or the IEEE parts store here on campus <http://www.engr.uky.edu/~ieeee/> The notebook will not be graded.

Lab Report Format: Lab reports must be prepared with a word processor and organized according to the following format:

Title Page: This includes your name, lab partner's name, title of lab experiment, date of experiment, and date of completing the final write up (**0.1 point off if not there**).

Abstract: In one paragraph concisely and effectively explains purpose of experimental work, and clearly summarizes findings shows (**1**).

Introduction: In several paragraphs clearly identify hypotheses/questions/objectives, with appropriate context. When grading this section the reader will ask the question, "What will this experiment show/resolve?" If it is not clear (due to missing information or lack of context), points will be lost (**0.5 points**).

Experimental Methods: Thoroughly explain experimental procedures, design of study/experiment, and data measurement techniques. If freedom is given in selecting samples/data measurements choice of sample range and repetitions should be justified and discussed. If a piece of software is used, describe what the program does (functional description) and include the actual code in an appendix. A flowchart can help explain the program in an efficient manner. The "how" questions for obtaining the results are answered in this section. When grading this section the reader will ask the question, "How can I repeat these measurements/experiments done to obtain the results?" If it is not clear (due to missing, poorly organized, or ambiguous information), points will be lost (**2 points**).

Results and Analysis: Report on collected data and provide appropriate/correct data visualization and summaries; Describe the procedure for analysis (i.e. connect the data to the questions raised in the introduction). For figures,

all axes must be labeled, for tables all columns and rows must be labeled (**no credit is given for a plot or table without proper labels**). All figures and tables should be numbered and referred to in the text. Do not include a table or figure without introducing and explaining it within the text. The purpose of the figure or table is to support the conclusions you are working toward in the report narrative. The actual data generated/recorded is presented in this section along with any analysis (formula or code description) used to estimate parameters or functions of the original data (**1 points**).

Conclusions: Based conclusion on analysis in previous section and clearly state it. Provide context so it is easy to understand. Identify issues which may affect the validity of the study/experiment as well as possible biases. Also discuss changes to be made if experiment/study were to be repeated to improve (**0.5 points**).

Lab Team Plan: It is strongly recommended that lab group members determine how the workload is to be divided up with *agreed-on* expectations for each member (written down). The main tasks of each lab typically includes planning out the lab activities, data processing, programming, documentation, record keeping of the lab procedures, presenting data, writing, and proofreading the lab reports. For **each** full lab clearly delineate responsibilities. You should try to rotate responsibilities in each lab so everyone gains experience at the different aspects of the lab activity. Also indicate scheduled times outside of the lab and lecture meetings to work on lab planning and lab reports. Since this is a 2 credit hour lab, 4-6 hours per week on average should be scheduled outside of class time to complete pre-lab and lab write-up assignments. A good lab plan lists the major components for each lab assignment, the person responsible, and the tentative time in the week that will be devoted to it over the whole semester. This is a tentative plan and can change with mutual agreement between lab partners. There is no direct credit given for this assignment, but is good practice for any group assignment.

Laboratory Presence: All team members must be ready for work at the beginning of class. There will be a sign in sheet when you enter the laboratory. You will enter the time at which you arrived next to your name and sign in. If you are less than 30 minutes late you will lose 0.5 points from the laboratory presence score. If you are over 30 minutes late and less than an hour, you will lose 1 point. If you are over an hour late, you will not get credit for the lab assignment. You can lose up to 9 points by being late over the course of the semester and potentially more points by receiving no credit for the lab assignment if you are over an hour late.

Lab assignments can be made up in the case of excused absences. The lab reports are due in the next lab meeting after the lab where measurements were completed, demos must be performed within the current lab meeting time.

EE422G Topics:

Labs will be implemented in Matlab, Simulink, and Labview. Some extra labs and lecture time will be given to some of the more involved topics.

- Lab 1. Sampling and Quantization (Aliasing and Noise)
- Lab 2. Signals and Noise Characterizations (Correlation and Spectrum)
- Lab 3. FIR Filter Design
- Lab 4. IIR Filter Design
- Lab 5. Filter Applications using signal and noise models
- Lab 6. Digital communication channel (Distortion and Noise)
- Lab 7. Correlation receiver simulation and performance (Matched Filter)
- Lab 8. Modulation
- Lab 9. Single-Sided Modulation (as an audio effect)
- Lab 10. PID control

Unethical behavior (cheating): The following activities are unethical:

- Using data you did not measure
- Recording values you did not observe
- Copying a portion of work belonging to someone else

Any of these will result in the consequences described in the university's policy on academic dishonesty, see Section 6.3 of: <http://www.uky.edu/StudentAffairs/Code/part2.html>

Tentative Course Schedule EE422G

Week	Lecture Dates	Lecture Topics	Laboratory Sessions	Assignments Due
1	8-28 (Intro)	Lab and course policies, Course overview/Review of signal and system concepts/Laboratory Software	9-2,3 Tutorials on Software	
2	9-4 (Review)	Transforms Review!	9-9,10 Tutorials on Software – Data capture	
3	9-11 (Lab1)	Sampling and Quantization	9-16,17 (Lab1)	Lab 1: Prelab due 9-16,17 and report due 9-23,24
4	9-18 (Lab 2)	Noise and Signal Characterizations	9-23,24 (Lab2)	Lab 2: Prelab due 9-23,24 and report due 9-30,10-1
5	9-25 (Lab 3)	Finite Impulse Response (FIR) filters Noise Models	9-30,10-1 (Lab3)	Lab 3: Prelab due 9-30,10-1 and report due 10-7,8
6	10-2 (Lab 4)	Infinite Impulse Response (IIR) filters	10-7,8 (Lab4)	Lab 4: Prelab due 10-7,8 and report due 10-14,15
7	10-9 (Lab 5)	Filter Application using signal and noise models	10-14,15 (Lab5)	Lab 5: Prelab due 10-14,15 and report due 10-21,22
8	10-16 (Lab 6)	Digital communication channels	10-21,22 (Lab6)	Lab 6: Prelab due 10-21,22 and report due 10-28,29
9	10-23 (Lab 7)	Correlation receiver simulation and performance estimate	10-28,29 (Lab7)	Lab 7: Prelab due 10-28,29 demo to be performed during lab period
10	10-30 (Lab 8)	Modulation	11-4,5 (Lab8)	Lab 8: Prelab due 11-4,5 demo to be performed during lab period
11	11-6 (Lab 9)	Modulation LabVIEW Program	11-11,12 (Lab9)	Lab 9: demo to be performed during lab period
12	11-13 (Lab 10)	PID Control, State Space Models	11-18,19 (Lab10)	Lab 10: Pre-lab due 11-18,19 demo during lab meeting
13	11-20 Project	Project challenge	Thanksgiving Holiday Week	
14	Thanksgiving Holiday week	Project	12-2,3	Project demos
15	12-4 Project	Project	12-9,10	Project demos