Spring 2025 EE 445S Real-Time Digital Signal Processing Laboratory Prof. Evans

Homework #6

Carrier Recovery, Timing Recovery and QAM Transmission

Assigned on Sunday, April 6, 2024
Due on Friday, April 11, 2025, 11:59pm by upload to Gradescope

Homework submitted after 11:59pm is subject to a penalty of 2 points per minute late.

Reading: Johnson, Sethares & Klein, Sections 9.4, 10.1-10.4, 12.1-12.4 and 16.1-16.2

This assignment is intended to continue building our foundation for transmitter and receiver design.

Office hours for the teaching assistants and Prof. Evans; **bold** indicates a 30-minute timeslot.

Time Slot	***Monday***	***Tuesday***	***Wednesday***	***Thursday***	***Friday***
10:30am	**Evans (ECJ 1.312)**		**Evans (ECJ 1.312)**		
11:00 am	Evans (ECJ 1.312)		Evans (ECJ 1.312)		
12:00 pm					Evans coffee hours (EER Cafe)
1:00 pm			Evans (EER 6.882 & Zoom)		Evans coffee hours (EER Cafe)
2:00 pm			Evans (EER 6.882 & Zoom)	Barati (TBA)	
3:00 pm				**Barati (TBA)**	
3:30 pm				**Eun (TBA)**	
4:00 pm				**Eun (TBA)**	**Eun (EER 1.810)**
4:30 pm			**Barati (EER 1.810)**	**Eun (TBA)**	**Eun (EER 1.810)**
5:00 pm			**Barati (EER 1.810)**		**Eun (EER 1.810)**
5:30 pm			**Barati (EER 1.810)**		

In your solutions, please put all work for problem 1 together, all work for problem 2 together, etc.

Please submit any MATLAB code that you have written for the homework solution

As stated on the course descriptor, "Discussion of homework questions is encouraged. Please be sure to submit your own independent homework solution."

6.1 Phase Locked Loop. 30 points.

Johnson, Sethares & Klein, exercise 10.21, on page 210.

6.2 Timing Recovery. 36 points.

Johnson, Sethares & Klein, exercise 12.17, on page 265. Please do the following additional part:

(b) Implement the algorithm in part (a) using clockrecOP.m as a basis and compare the behavior with the output power maximization approach in terms of convergence speed (i.e. number of iterations needed for the same value of the step size to find the symbol timing offset tau).

6.3 Simulation of 4-QAM and 16-QAM Transmission. 34 points.

Johnson, Sethares & Klein, exercise 16.2, on page 362.

Please see Fig. 16.12 on page 381 and read accompanying text. Plotting symbol error rate vs. signal-to-noise ratio is a very common first step in analyzing communication system performance. This curve plots the lower bound from a formula. Another way to use this graphical representation is to simulate a communication system for different SNR settings and scatter plot the results. This could allow comparison of two equalization methods, two timing recovery methods, etc. Superimposing the lower bound from a formula on the plot shows how close (or far away) the methods are from the ideal answer.

Please read the online hints for homework #6.