HW#7 Simulations

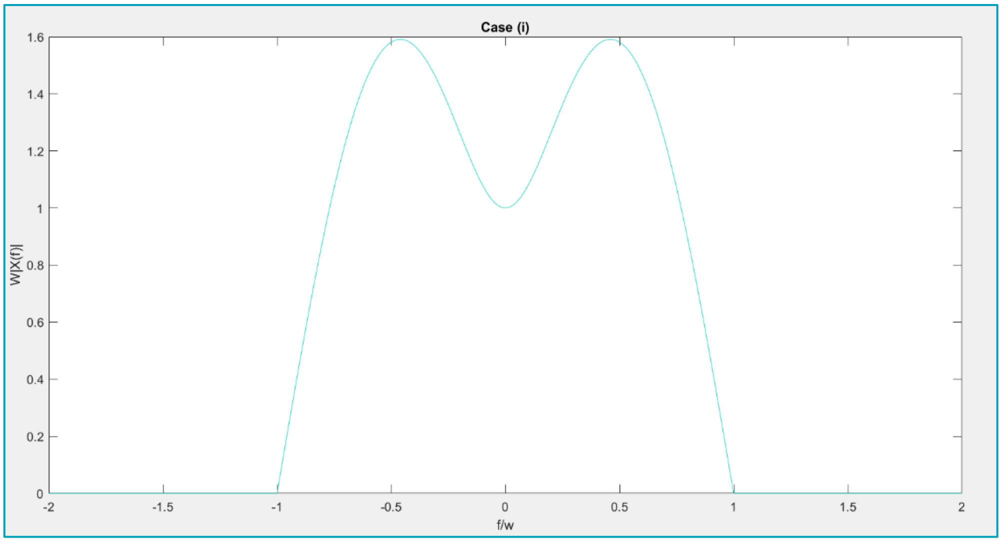
ADVANCED COMMUNICATION SYSTEMS

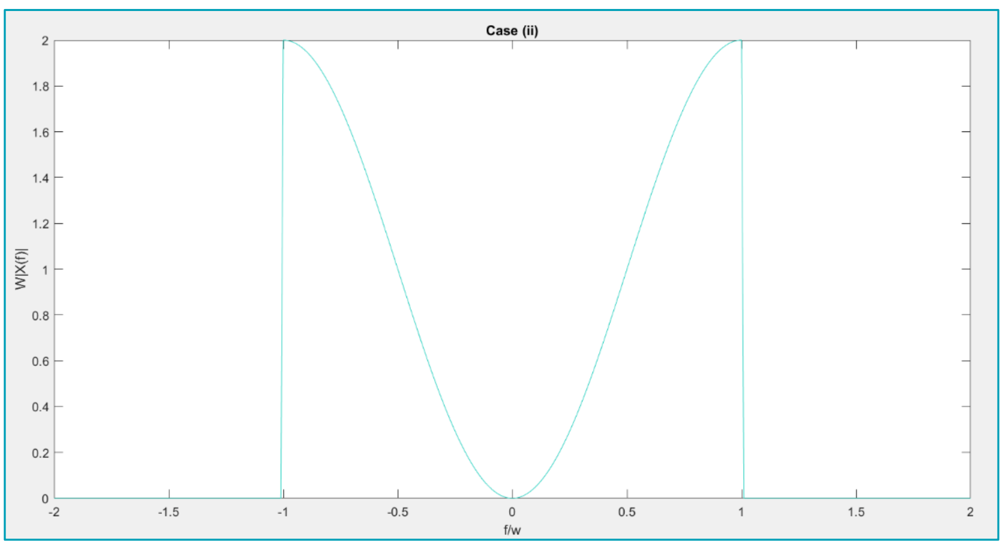
Fateme Noorzad | 810198271 | spring 1399

Problem 10:

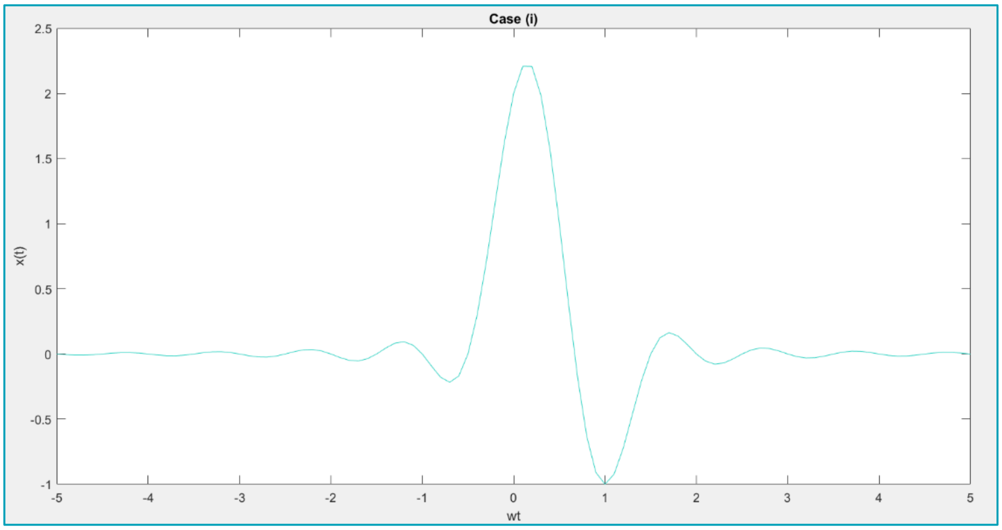
PART A:

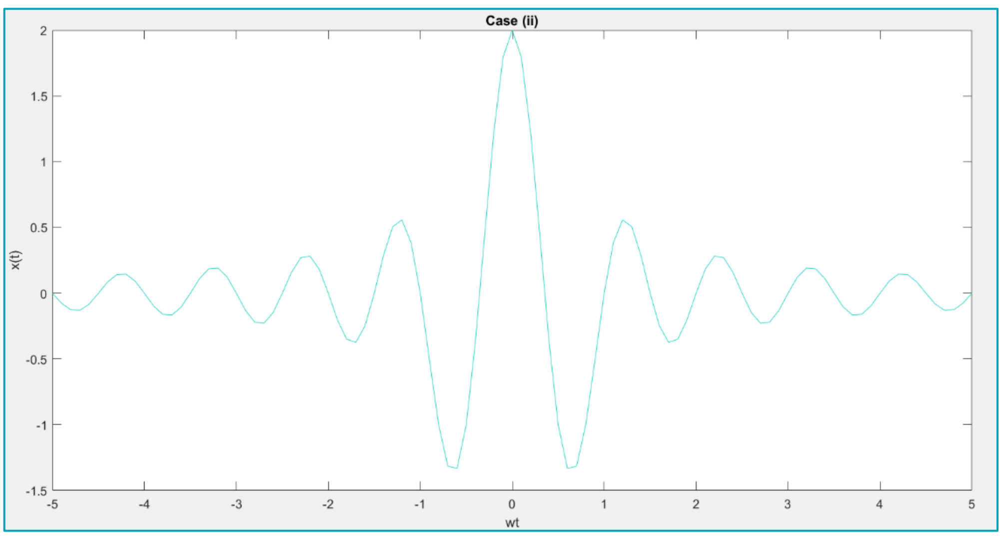
In this problem it is asked to plot $|X(f)|$ in 2 different cases, which can be found below:



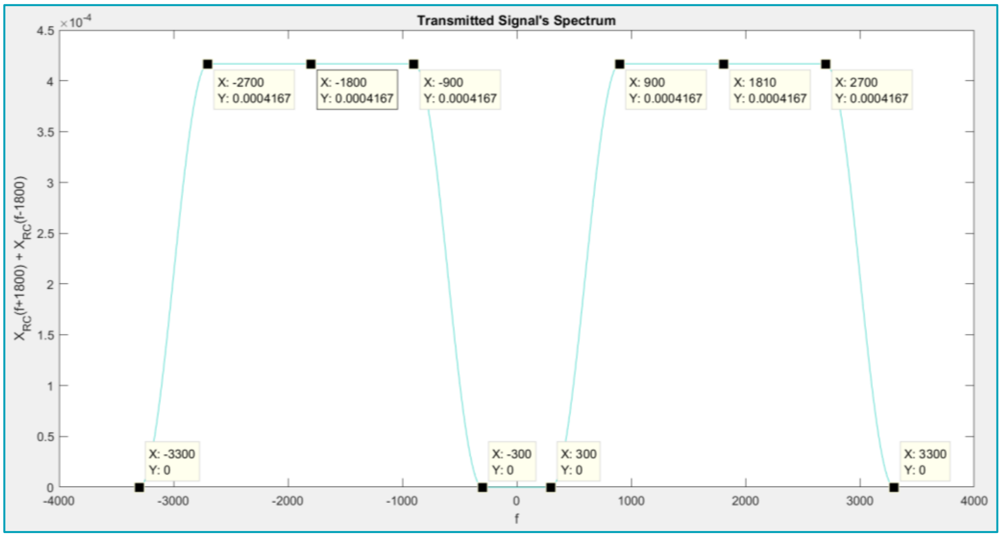


PART B:





Problem 14:



Simulation Problem:

PART C:

First "Viterbi Algorithm" is implemented for BPSK in the absence of noise.

Implementation of Filters:

As was said in this part BPSK modulation is used for sending bits, so bits are either +1 or -1. After simulating them, they first go through a pulse shaping filter represented by "g(t)" and then these symbols, pass channel which is represented by "c(t)". In part a h(t) which is convolution of g(t) and c(t) is calculated.

As can be seen in the given diagram, in the receiver part, we also have a pulse shaper which is represented by "h*(-t)".

So in order to sum up the input bits pass through a filter "x(t) = h(t) * h*(-t)". Then each 1 second the resulting pulse is sampled to created u_k . In addition a AWGN goes through "h*(-t)" and sampled each second which created discrete pulses v_k. Adding u_k to v_k results in y_k symbols. These symbols are the ones that need to be detected using "Viterbi Algorithm".

Implementation of Viterbi Algorithm:

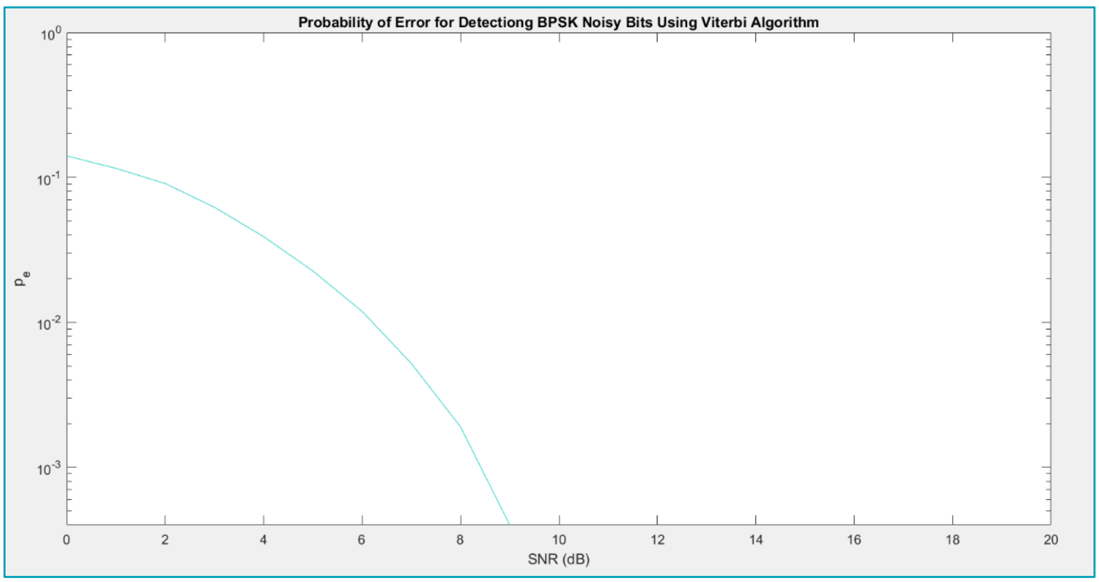
In order to simulate this algorithm, the below relation is simulated:

$$c(\mathbb{I}_n) = c(\mathbb{I}_{n-۱}) + Re\{ I_n{}^*(۲\, y_n - x_o I_n - ۲\sum_{m=۱}^{L} x_m I_{n-m})\}$$

Which based on part a's calculations we have: $L = 2$, $x_0 = 5/6$, $x_1 = ½$, $x_2 = 1/12$

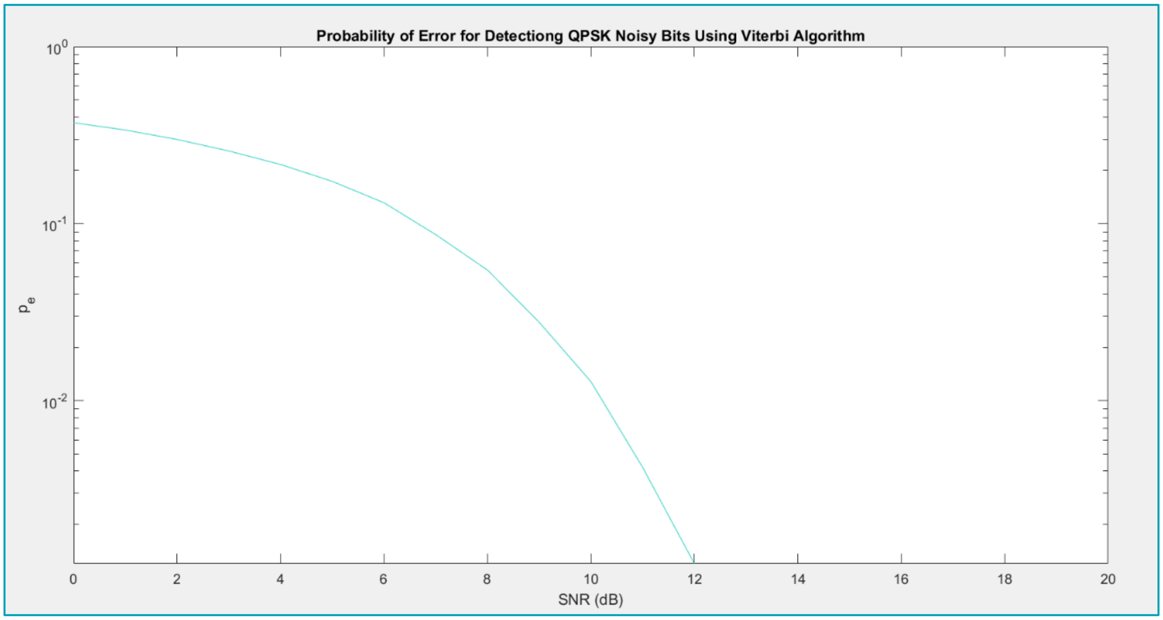
In this part as been said $I_n \in \{\pm 1\}$, so the algorithm is implemented based on these values and equations and also the fact that no noise is added. As we expect because noise has no contribution, Viterbi must cancel all ISIs, resulting in zero probability of error. This expectation is perfectly handled and can be seen in the attached file "BPSK_WITHOUT_NOISE.m".

After making sure that our implementation is correct noise is added and the resulting probability of error based on 0-20 Db SNR is calculated. (As part b suggest, a white Gaussian noise's variance is set based on different values of SNR.)



PART D:

This part is a lot like last part but with keeping in mind that QPSK symbols are given in the problem as $I_n = \left\{ \pm \frac{۱}{\sqrt{۲}} \pm j \frac{۱}{\sqrt{۲}} \right\}$. Again same as last part, Viterbi algorithm is done without noise to check the algorithm and then noise is added, resulting in the below plot:


Probability of Error for Detectiong QPSK Noisy Bits Using Viterbi Algorithm
10^0
10^-1
10^-2
p_e
0
2
4
6
8
10
12
14
16
18
20
SNR (dB)