SDMN-Wireless HW1 - EE Department – SUT **Due Date: 16 Esfand 1398**

1- The goal of this problem is to simulate a basic OFDM system without any channel. Consider a series of 0 and 1 bits that are modulated as 0 and 1 values and sent to the IFFT block. We want to see the relationship between frequency and time domains. Lets assume that the system uses N=1024 subchannels in a total 15,36MHz band.
   a) Find the length of the OFDM symbol in seconds, without any CP added. Also, what is the sampling rate of time domain samples at the output of the OFDM block?
   b) Assume all bits of a symbol are zero and only the second bit is 1. Plot the time domain output of IFFT block for 10240 input bits.
   c) Now pass the time domain signal through the receiver FFT block and plot its output. Is the received bit the same as the transmitted one?
   d) Now generate a stream of 10240 random 0 and 1 input bits and check the output again. Is there any error?

   Deliverable: Only send the answers to part 1a, 1c and 1d. Plots are of course needed to make sure your coding is working fine, but no plot should be submitted.

2- In this part, we add a 2-path channel and see the effect of channel. Lets assume one path is direct path with no loss and no delay and the second path with amplitude of 0.8 and delay of tau second. Use time domain convolution to compute the output of channel.
   a) Set tau equal to 5usec. Now plot the output time domain signals of part1d and also at the receiver and compute the bit error rate. In this case assume no guard time is added. Note that in passing the signal through the channel, your channel impulse response should be sampled a the same rate as the input signal (refer to part 1a).
   b) Now add a guard time of 5.7usec and do part 2a again. In this part assume the guard time to be all zeros (zero-padded guard time).
   c) Now use Cyclic prefix and do part 2b again. What is the difference between part 2b and 2c?

   Deliverable: Only submit answer to part 2c. . Plots are of course needed to make sure your coding is working fine, but no plot should be submitted.

3- In this part, we want to look at the OFDM signals in frequency domain. The goal is to fully remove the effect of channel at the receiver using what is known as the **Frequency domain equalizer**.
   a) To do that, instead of using time domain convolution as we did in part 2a, we take the FFT of OFDM input signal x, and also the FFT of channel h, multiply them to get the FFT of the channel output y. If we call the FFT of these signals at subcarrier i as Xi, Hi and Yi, is the equation Y=H.X correct? If not, why? (Hint: The Y=X.H is correct if we take **circular** convolution of x and h in time domain and not their normal convolution)
   b) Based on the result of part 3a, think about the reason why using CP and not just zero pad is important and what key role is choosing the guard time as cyclic prefix is playing that normal zero pad will not do?
   c) If we have the channel impulse response and compute its FFT to find H, and Y is equal to H.X, then we can then use the equation Xi = Yi / Hi and equalize the channel at each subcarrier independent of other frequencies. Pls use this equation to repeat part 2c by doing a frequency domain equalization at the receiver side and then compute signal x at the receiver again. Is this the same as what you have obtained in time domain in part 2c? Which one has a better bit error rate?

   Deliverable: Answer to parts 3a,b,c. No plots should be submitted.

The answer sheet to this HW, should be at most **ONE PAGE**. No grade is given to answers of more than one page.