Wireless Communication IC

Homework #1

(Due on 03/14)

Total points: 120 points

1. Please randomly generate 8 binary bits (ref. Matlab commands: **rand**) by using your last two digits as the seed, and write down your own bits $(b_i, i = 0,1, \ldots 7)$.

2. Use the binary bits generated in Question 1. For the following questions, the symbol period (T) is set to 400ns. The carrier frequency (f_c) is selected to be 10 MHz. The initial phase, if required, is zero. Note that to make the waveform smooth, at least 16 points are sampled for one sin/cos cycle. (ref. Matlab commands: **plot**, **cos, sin, linspace, ifft**)
   (a) Plot FSK waveform after modulation with carrier f_c, if bit 1 is sent, carrier frequency is increase to 15MHz. Otherwise, carrier frequency is decreased to 5 MHz. So, the length of the whole waveform is 3200ns. Please pay attention to the unit of your x-axis and correctly label the x axis and y axis. (10%)
   (b) Use the black constellation mapping as in Fig. 1. Plot QPSK waveform after modulation with carrier f_c. So, the length of the whole waveform is 1.6μs. (10%)
   (c) Use the black constellation mapping for the first symbol of even-numbered student and the white constellation mapping for the first symbol of odd-numbered students. Plot π/4-QPSK waveform after modulation with carrier f_c. So, the length of the whole waveform is 1.6μs. (10%)
   (d) Plot O-QPSK and π/4-DQPSK **baseband** waveform (containing real-part and imaginary-part) according to the black points of the constellation given in Fig. 1 (10%) and two waveforms **after modulation** with carrier f_c (20%). Assume that the symbol before time 0 is $(1 + \mathrm{j})/\sqrt{2}$ for both cases. So, the length of the whole waveform to be checked is 1.6μs.
   The phase shift of π/4-DQPSK is defined as
   Dibits=00 -> π/4, Dibits=11 -> 3π/4,
   Dibits=01 -> -π/4, Dibits=10 -> -3π/4)

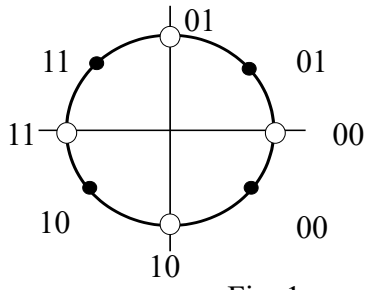

Fig. 1

3. Use the data from Q1. Plot OFDM **baseband** signals with **8** subcarriers by the following step:
   (a) With the symbol period of 800ns, calculate the subcarrier spacing f_{sub} and sampling interval T_s (10%) So, in the following, the length of the whole waveform is 0.8μs. Please pay attention to the unit of your x-axis and y-axis.
   (b) Use BPSK constellation mapping for each subcarrier. For data bit 1, signal +1 is used. For data bit 0, signal -1 is used. Write down your X_k. Draw the real part of the signals at eight subcarriers. $X_k e^{j2\pi f_k t}$ for $k = 0,1,\dots,6,7$. Note that $f_k = kf_{sub}$. Also, in order to make the waveform smooth, at least 16 points are sampled for one sin/cos cycle. (20%)
   (c) Sum your waveform of 8 subcarriers and draw the real part and imaginary part of the output. $y(t) = \sum_{k=0}^{7} X_k e^{j2\pi f_k t}$ (10%)
   (d) Calculate the time-domain waveform including real part and imaginary part by applying 8-point IFFT to the frequency-domain signals X_k for $k = 0,1,2,\dots 7$. Draw the discrete real part and imaginary part outputs with proper sampling interval T_s from (a). (10%).
   (e) First, scale the curve in (c) by 1/8. Then, on the same figure, use "stem" to draw the waveform of (d) with proper sampling interval T_s according to (a). Compare them and write your comments. (10%)