ELEG 5693 Assignment # 5

1. Prove that the following modulation system is non-linear.

$$s(t) = A_c\left[1 + k_a m(t)\right]\cos(2\pi f_c t). \tag{1}$$

2. Based on the constellation given in lecture slides, find out the baseband modulation symbols for the binary sequence 001001110101

   (a) BPSK

   (b) QPSK

   (c) 8PSK

   (d) 16QAM

3. A communication system has a data rate of 1 Mbps. Root raised cosine filter will roll-off factor $\alpha = 0.3$ is used at both transmitter and receiver. Find the pass-band bandwidth of the signal for the following modulation schemes

   (a) BPSK

   (b) 16QAM

4. (a) write a Matlab function $\mathbf{rcos}(\mathbf{t}, \mathbf{Ts}, \alpha)$ to generate the raised consine function. t is a vector used to describe the points on time domain axis, T_s is the symbol period, and α is the roll-off factor.

   (b) In one figure, use Matlab plot the time domain responses of raised consine filter with $\alpha = 0.15, \alpha = 0.55, \alpha = 0.95$, respectively. Set $T_s = 1$, and $t \in [-5T_s, 5T_s]$. (set $T_{res} = T_s/100$ to approximate the continuous-time waveform.)

5. For binary sequence [0 1 1], we want to generate the waveform after baseband BPSK modulation and pulse shaping. Use $\alpha = 0.35$.

(a) The baseband BPSK modulated symbols are [-1 1 1]. Plot the individual waveforms for the three symbols after raised consine filter: $-1 \times \text{rcos}(t, Ts, \alpha)$, $1 \times \text{rcos}(t - Ts, Ts, \alpha)$, $1 \times \text{rcos}(t - 2Ts, Ts, \alpha)$. Plot them in the same figure.

(b) In a new figure, plot the overall waveform $\sum_{n=0}^{2} x_n \text{rcos}(t - nTs, Ts, \alpha)$. On the figure, mark the points corresponding to the sampling instant at receiver, and write down the values of samples. Is there interference among the three samples?