AV332: Digital Communication Lab

Lab 7
Baseband pulse shaping, ISI, and Eye Diagrams in MATLAB — Date: 3rd and 6th October 2016

Please note that this experiment has to be done in MATLAB.

1 Baseband pulse generation

Prelab assignments

1. Familiarize yourself with the DFT and FFT for discrete time signals.
2. Think about how to represent continuous time signals in MATLAB. Also think about how to represent continuous time LTI systems (with a continuous time impulse response) in MATLAB, and how their operation on continuous time signals can be simulated in MATLAB.
3. Study the following functions in MATLAB: (a) fft, (b) fftshift, (c) convolve, (d) rand.

In lab tasks

1. Implement a MATLAB function to generate a rectangular pulse with amplitude A, a duration T_b, and a start time T_s. The function should also take in a time index as an input argument.
2. Implement a MATLAB function to generate the following truncated sinc pulse
$$AT_b \frac{sin\left(\pi \frac{(t-T_s)}{T_b}\right)}{t-T_s}$$
in the interval $[T_s - T_d/2, T_s + T_d/2]$. The function should also take in a time index as an input argument.
3. Implement a MATLAB function to generate a raised-cosine pulse with amplitude A, i.e.,
$$AT_b \frac{sin\left(\pi \frac{(t-T_s)}{T_b}\right)}{t-T_s} \frac{cos\left(\pi\alpha \frac{t-T_s}{T_b}\right)}{\left(1-\left(2\alpha\frac{t-T_s}{Tb}\right)^2\right)}.$$
in the interval $[T_s - T_d/2, T_s + T_d/2]$. The function should also take in a time index as an input argument.
4. Use the functions that you have written above to generate a rectangular, sinc, and raised-cosine pulse and then obtain the magnitude spectrums of the three pulses. Compare with the theoretical magnitude spectrums of the three pulses (where $T_d = \infty$).

2 Intersymbol interference

In lab tasks

1. Obtain the pulse shapes obtained when rectangular, sinc, and raised-cosine pulses are passed through a filter with impulse response given by $h(t) = 0.1e^{-t}$.
2. Obtain the magnitude spectrum of the output pulse shapes.
3. Generate a random independent and identically distributed sequence of bits with equal probability of a bit being 0 or 1. The length of the sequence should be $N = 10$.
4. Generate the baseband PAM signal corresponding to the above bit sequence when using the rectangular, sinc, and raised cosine pulse shapes for $N = 10$. Let $T_b = 2$ for the baseband PAM signals.
5. Obtain the output of the filter when the baseband PAM signal obtained above is fed into it for the three pulse shapes. Obtain the output magnitude spectrums also. How do the magnitude spectrums change as a function of T_b? (try $T_b = 0.5, 1, 2.5, 4$).
6. If sampling is done perfectly, i.e., at the middle of the bit period what is the sampled output sequence?
7. An optional task is to study the number of bits which are received in error. Suppose sampling is done at points in time which are Δ offset from the middle of the bit period. Study how the number of bits received in error varies as a function of Δ. In this case, you would need to increase N to 1000 and average the number of bits obtained for multiple runs of your simulation.

3 Eye diagram

Prelab assignments

1. Find out what an eye diagram is, either from the textbook or from other sources such as the internet.

In lab tasks

1. Generate eye diagrams for each of the pulse shapes before and after they are passed through the filter with impulse response $h(t)$. For this you can use the baseband PAM signal obtained in the previous task for a random bit sequence. Compare and contrast the input and output for each pulse shape as well as between pulse shapes.