Indian Institute of Space Science and Technology
AVD623 - Assignment 2
Department of Avionics

Assignment 2
Matlab programming assignment

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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.

4. Implement a MATLAB function to generate a rectangular pulse with amplitude A, a duration T_b, and a start time T_s. Since the pulse is represented in discrete time, the function should also take in a vector of time indices as an input argument.

5. Implement a MATLAB function to generate the following truncated sinc pulse

$$AT_b \frac{sin(\pi \frac{(t-T_s)}{T_b})}{t-T_s}$$

in the interval $[T_s - T_d/2, T_s + T_d/2]$. Since the pulse is represented in discrete time, the function should also take in a vector of time indices as an input argument.

6. Implement a MATLAB function to generate a raised-cosine pulse with amplitude A, i.e.,

$$AT_b \frac{sin(\pi \frac{(t-T_s)}{T_b})}{t-T_s} \frac{cos(\pi\alpha \frac{t-T_s}{T_b})}{(1-(2\alpha \frac{t-T_s}{Tb})^2)}.$$

in the interval $[T_s - T_d/2, T_s + T_d/2]$. Since the pulse is represented in discrete time, the function should also take in a vector of time indices as an input argument.

7. 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 $T_d = \infty$).

8. Obtain the pulse shapes obtained when rectangular, sinc, and raised-cosine pulses are passed through a filter with impulse response given by $h(t) = 0.1e^{-t}$.

9. Obtain the magnitude spectrum of the output pulse shapes.

10. 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 $N = 10$.

11. 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.

12. 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 $T_b = 0.5, 1, 2.5, 4$).

13. If sampling is done perfectly, i.e., at the middle of the bit period what is the sampled output sequence?

14. How does timing jitter affect decoding of bits sent using sinc PAM? Using a simulation study, obtain the average fraction of bits decoded in error as a function of the timing jitter offset. Assume that the source puts out bits according to an IID process with uniform probability. Assume that $r_b = 1 bit/sec$ and the baseband channel bandwidth is $2r_b$.

15. How does timing jitter affect decoding of bits sent using raised cosine pulse shaping?