EEE 391

Basics of Signals and Systems

Spring 2016–2017

Computer Assignment 2

due: 3 April 2017, Monday, by 23:55 on moodle

Reconstruction in the Time Domain:

Write a MATLAB code for reconstruction in the time domain using the different types of pulse signals $p(t)$ given in (i), (ii), (iii), and (iv). Your code should implement the following equation:

$$y(t) = \sum_{n=-\infty}^{\infty} y[n]\, p(t - nT_s)$$

where $y[n]$ are the samples of a discrete-time sequence and $y(t)$ is the reconstructed signal. The program should be able to take any sequence $y[n]$ of finite duration and the sampling period T_s as input. The user should be able to select from a menu of four types of pulse signals:

(i) standard square pulse of duration T_s:

$$p(t) = \begin{cases} 1 & \text{for} \quad -\frac{T_s}{2} \leq t \leq \frac{T_s}{2} \\ 0 & \text{otherwise} \end{cases}$$

(ii) standard triangular pulse of duration $2T_s$:

$$p(t) = \begin{cases} 1 - \frac{|t|}{T_s} & \text{for} \quad -T_s \leq t \leq T_s \\ 0 & \text{otherwise} \end{cases}$$

(iii) a pulse signal consisting of three parabolic segments (of total duration $4T_s$). You can design this pulse yourself so that the middle segment has a peak value of one, and the two segments on each side of it make a good match to the ideal sinc pulse.

(iv) truncated ideal pulse:

$$p(t) = \begin{cases} \frac{\sin\left(\frac{\pi}{T_s} t\right)}{\frac{\pi}{T_s} t} & \text{for} \quad -3T_s \leq t \leq 3T_s \\ 0 & \text{otherwise} \end{cases}$$

Demonstrate that your program works properly by using each of the pulse types i)–iv) on the following two sequences for reconstruction:

(a)

$$
\begin{aligned}
y[-3] &= \text{1st digit of ID number (leftmost digit)} \\
y[-2] &= -\text{2nd digit of ID number} \\
y[-1] &= 0 \\
y[0] &= \text{3rd digit of ID number} \\
y[1] &= -\text{4th digit of ID number} \\
y[2] &= \text{5th digit of ID number} \\
y[3] &= 0 \\
y[4] &= -\text{6th digit of ID number} \\
y[5] &= \text{7th digit of ID number} \\
y[6] &= \text{8th digit of ID number (rightmost digit)} \\
y[n] &= 0 \quad \text{otherwise} \quad (-\infty < n < \infty)
\end{aligned}
$$

(b) the double-sided exponential sequence:

$$
y[n] = \begin{cases} 10\, e^{-0.25|n|} & \text{for } \; -12 \le n \le 12 \\ 0 & \text{otherwise} \end{cases}
$$

For parts (a) and (b), your program should provide the reconstructed signal $y(t)$ as output. That is, for each pulse type, plot the discrete-time sequence $y[n]$ and the reconstructed signal $y(t)$ on the same figure. Use different colors or line styles and label them with the “legend” command. Interpret your results and provide a brief discussion on the selection of the pulse type.

(c) For the truncated ideal pulse given in (iv) above, assume that the ideal pulse is now truncated at $\pm 5T_s$ instead of $\pm 3T_s$. Provide the results of reconstructing the two sequences in parts (a) and (b) for this modified case. Compare the results of truncating at $\pm 5T_s$ with those of truncating at $\pm 3T_s$ by plotting both of the reconstructed signals on the same figure. If necessary, zoom in to observe the difference between the two signals. Interpret your results and provide a brief discussion on the effect of the selection of the wider pulse.

Submit the results of your own work in the form of a well-documented report on moodle. Borrowing full or partial code from your peers or elsewhere is not allowed and will be punished. Please include all evidence (plots, screen dumps, MATLAB codes, MATLAB command window print-outs, etc.) as needed in your report. Append your MATLAB code at the end of your assignment, do not upload it separately. The axes of all plots should be scaled and labeled. Typing your report instead of handwriting some parts will be better. Please do not upload any photos/images of your report. Your complete report should be uploaded on moodle as a single good-quality pdf file by the given deadline. Please DO NOT submit any hardcopies or files by e-mail or on memory stick/CD.