ENGR 253 LAB #4 - Linear Time-Invariant Systems & Convolution

Objective
Utilize MATLAB to calculate and plot LTI system response with convolution.

Resources
- Signals & Systems textbook by Oppenheim and Willsky
- Windows running MATLAB release 14 or later
- USB hard disk or other removable drives (note Lab computer data is lost after reboot)
- Course Lecture Material

Background
- Calculation of LTI system response using the convolution of input signal and impulse response.
  - Continuous-time {y(t) = x(t)* h(t)}

$$y(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$$

  - Discrete-time {y[n] = x[n]* h[n]}

$$y[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k]$$

- Conv(A,B)
  C = CONV(A, B) convolves vectors A and B. The resulting vector is length LENGTH(A)+LENGTH(B)-1.

- Timing Utilities
  At times, you are required to analyze the performance of your function. MATLAB offers functions clock() and etime() for determination of elapsed time.

  - t_1 = clock() returns a 6-element date vector containing the current date and time in decimal form:

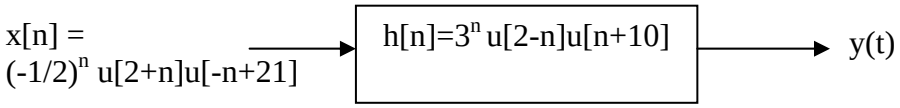
    t_1 = [year month day hour minute seconds]

  - e = etime(t_2, t_1) returns the time in seconds between date vectors t_1 and t_2.

  - tic() and toc() functions may provide a more precise approach to timing code in MATLAB.

Experiment #1

Identify the intervals of interest for performing the convolution {x[n]*h[n]} on the following LTI system. This experiment requires that you write the summations for each interval of interest, but does not require you to simplify the summations.



Experiment #2

Utilizing the LTI system definition from Experiment #1, write a MATLAB function that calculates and plots the system response, y[n], to input, x[n], without the use of MATLAB's conv(), fft(), filter() or related functions.

Experiment #3

Utilizing the LTI system definition from Experiment #1, write a MATLAB function that calculates and plots the system response, y[n], to input, x[n], using MATLAB's conv(), fft(), filter() or related functions.

Experiment #4

Compare the function developed in Experiment #2 and #3 including the performance in term of function execution time.

Report Requirements

Reports must be prepared individually even if the experiments are performed as a team. All reports must be computer printed (Formulas and Diagrams may be hand drawn) and at minimum include:

For each Experiment

a) A clear problem statement; specifying items given and to be found.
b) Theory or process used.
c) Resulting circuits, calculation, tables, timing diagram, schematic and other relevant results.

For the report as a whole

a) Cover sheet with your name, class, lab, completion date and team members' names.
b) Lessons Learned from the experiments.
c) A new experiment and expected results which provide additional opportunity to practice the concepts in this lab.