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

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

Resources
- Course Lecture Material
- MATLAB or GNU Octave Development Environment

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:

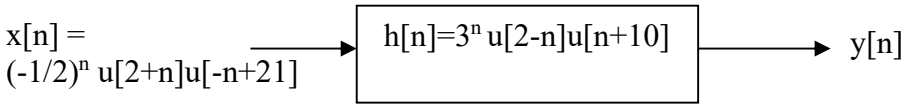
    t_1 = [year month day hour minute seconds]

  - 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 graphs the system response $y[n]$ with respect to 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 graphs the system response $y[n]$ with respect to 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

Lab and reports must be completed individually. 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.