In the Name of God

University of Tehran

Electrical and Computer Engineering faculty

Signals and Systems, Fall 95

Computer Assignment #1

Due Date: Friday, 7 Abaan 1395, 11:55 PM

You may find the two PDF files uploaded, useful for answering the problems. Problems are easy to understand. Use MATLAB mfile to write and run your codes according to the format mentioned in the PDF file that I sent you before.

Problem 1

1. Plot the continuous-time signal $x(t) = u(t+1) - u(t-2) + u(t-4)$

   1.a) Without using the command Heaviside

   1.b) Using the command Heaviside

   - Use '*subplot*' command to plot the wanted signals in one figure.

2. Plot the signal $x(t) = t\sin(2\pi t)\left(u(t) - u(t-3)\right)$

   2.a) Without using the command Heaviside

   2.b) Using the command Heaviside

   - Use '*subplot*' command to plot the wanted signals in one figure.

3. Plot the continuous-time signal $x(t) = 2r(t+2) - 4r(t) + r(t-2) + 3r(t-3) - u(t-3)$ using '*stepfun*' and '*ramp*' function

4. One way of transmitting a message over the airwaves is to multiply it by a sinusoid of frequency higher than those in the message, thus changing the frequency content of the signal. The resulting signal is called an amplitude modulated (AM) signal: the message changes the amplitude of the sinusoid. To recover the message from the transmitted signal, one can relate the envelope of the modulated signal to the message. Use the generated signal in part 3 to modulate a so-called carrier signal $y(t) = \sin(5\pi t)$ to give the AM modulated signal $z(t) = \mathrm{x}(\mathrm{t})\mathrm{y}(\mathrm{t})$. Obtain a script to generate the AM signal, and to plot it.

Problem 2

1. Consider the signal $x(t) = te^{-t}, 0 \leq t \leq 5$. Plot

   1.a) The signal $x(t)$

   1.b) The even decomposition $x_e(t)$ of $x(t)$

   1.c) The odd decomposition $x_o(t)$ of $x(t)$

   1.d) The signal $y(t) = x_e(t) + x_o(t)$

   - Use '*subplot*' command to plot the wanted signals in one figure.

2. Suppose that $x(t) = t\cos(2\pi t), 0 \leq t \leq 5$. Plot the signals

   • $x(t)$ • $x(-t)$ • $x(t/5)$ • $x(1+3t)$

   - Use '*subplot*' command to plot the wanted signals in one figure.

3. Suppose that $x[n] = n\, e^{-n}, -10 \leq n \leq 10$. Plot the signals

   • $x(2n)$ • $x(n/2)$

   - Use '*subplot*' command to plot the wanted signals in one figure.

Problem 3

Consider these two signals which are defined for all values of *t*

$x_1(t) = e^{-|t|}$ $\qquad$ $x_2(t) = |\sin(\pi t)|$

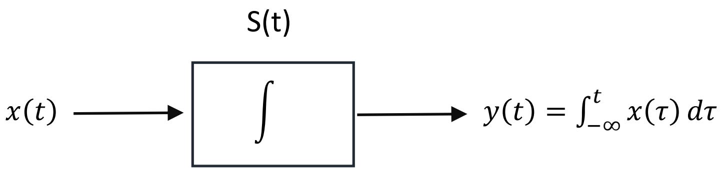
1. Plot the signals. (This is optional and for your comprehension and doesn't have to be included it in your report)
2. Determine whether these signals are finite energy or finite power and find energy or power of signals if your answers are positive.
3. Repeat part 1. This time, use *symbolic* MATLAB to check if the signals have finite power or finite energy. Compare your answers with part 1.
4. (optional) Given the discrete signal $x[n] = 0.5^n u[n]$. Is this a finite-energy discrete-time signal? i.e., compute the infinite sum

$$\varepsilon_x = \sum_{n=-\infty}^{\infty} |x[n]|^2$$

Verify your results by using symbolic MATLAB to find an expression for the above sum.

Problem 4

An integrator system is depicted in the figure below.



The i/o relationship of this system is

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

Determine if the integrator system is LTI.

- Hints
  1. Use signals $x_1(t) = u(t) - u(t-2)$ and $x_2(t) = u(t) - u(t-3)$, and the scalars $a_1 = 2$ and $a_2 = 3$ to examine the linearity property of the system. The relationship that must be fulfilled in order for the system to be linear is

  $$S\{a_1 x_1(t) + a_2 x_2(t)\} = a_1 S\{x_1(t)\} + S\{a_2 x_2(t)\}$$

  Represent left side and right side of above relation in one figure using '*subplot*' command.

  2. Find the response of the system to the input signal $x(t) = u(t) - u(t-2)$.Then Shift it to the right for 3 units and plot it (y_1). Then plot the response y_2, to its shifted version, $x(t-3)$ to check whether y_1 and y_2 are the same and system is time invariant.

  Represent y_1 and y_2 in one figure using '*subplot*' command

- You can use *symbolic* variables or vector as it is convenient for you. Also can use *'heaviside'* or *'stepfun'*.

This part includes some interesting features of signals which can be discovered by MATLAB. You may try them and there is no need to submit the results

1. **Chirps-**Pure tones or sinusoids are not very interesting to listen to. Modulation and other techniques are used to generate more interesting sounds. Chirps, which are sinusoids with time-varying frequency, are some of those more interesting sounds. For instance, the following is a chirp signal

$$y(t) = A\cos(\Omega_c t + s(t))$$

1.a) Let $A = 1$, $\Omega_c = 2$ and $s(t) = t^2/4$. Use MATLAB to plot this signal for $0 \leq t \leq 40$ sec in steps of 0.05 sec. Use *'sound'* to listen to the signal.

1.b) Let $A = 1$, $\Omega_c = 2$ and $s(t) = -2\sin(t)$. Use MATLAB to plot this signal for $0 \leq t \leq 40$ sec in steps of 0.05 sec. Use *'sound'* to listen to the signal.

1.c) What is the frequency of a chirp? It is not clear. The instantaneous frequency $IF(t)$ is the derivative with respect to *t* of the argument of the cosine. For instance, for a cosine $\cos(\Omega_0 t)$ the $IF(t) = d\Omega_0 t/dt$ so that the instantaneous frequency coincides with the conventional frequency. Determine the instantaneous frequencies of the two chirps and plot them.