Signals and Systems

Assignment -1

Unit - 1 and Unit - 2

1 Unit - 1

1. A Rectangular pulse $x(t)$ is defined by

$$x(t) = \begin{cases} 10, & 0 \leq t \leq 5; \\ \\ 0, & otherwise \end{cases}$$

   Write a MATLAB file to generate $x(t)$ using a pair of time shifted step functions.

2. An exponentially damped sinusoidal signal is defined by

$$x(t) = 20sin\left(2\pi 1000t - \frac{\pi}{3}\right)e^{-at}$$

   where the exponential parameter a is variable; it takes on the following set of values $a : 5, 7.5, 10$. Using MATLAB, investigate the effect of varying a on the signal for $-2 \leq t \leq 2$ milliseconds.

3. Write a user defined MATLAB function for the following operations on independent variable t:

   a. Time scaling: $CTscaling(t, x, a)$

   b. Time shifting: $CTshifting(t, x, b)$

   c. Time reflection: $CTreversal(t, x)$

   where t is time, x is the continuous-time signal, a is the scaling factor and b is the time shift factor. Using the above user defined functions, perform scaling with $a = 0.5, 5/2, 4$; time shift $b = 1/2, -3/2, 5$ and reversal for the signal $x(t)$.

4. Write a user defined MATLAB function for the following operations on independent variable n:

   a. Time scaling: $DTscaling(n, x, a)$

   b. Time shifting: $DTshifting(n, x, b)$

   c. Time reflection: $DTreversal(n, x)$

   where n is samples, x is the discrete-time signal, a is the scaling factor and b is the time shift factor. Using the above user defined functions, perform scaling with $a = 1/2, 5/2, 4$; time shift $b = 2, -5$ and reversal for the signal $x(n)$.

2 Unit - 2

1. The input signal $x(t) = e^{-t}u(t)$ is applied to an LTI system whose impulse response is given by

$$h(t) = \begin{cases} 1-t, & 0 \leq t \leq 1; \\ 0, & otherwise \end{cases}$$

Calculate the output of the system.

a. Write MATLAB code to find the convolution (without using inbuilt function).

b. Verify the answer of part (a) by using inbuilt function *conv*.

c. Plot the input, impulse response and output of the LTI System.

2. The input signal $x(n) = u(n-2) - u(n-7)$ is applied to an LTI system whose impulse response is given by

$$h(n) = \begin{cases} 1, & 0 \leq n \leq 10; \\ 0, & otherwise \end{cases}$$

Calculate the output of the system.

a. Write MATLAB code to find the convolution (without using inbuilt function).

b. Verify the answer of part (a) by using inbuilt function *conv*.

c. Plot the input, impulse response and output of the LTI System.

3. Compute the solution for the following second-order differential equation:

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 4y(t) = 3\cos(t)u(t)$$

with initial conditions $y(0) = 2$ and $\frac{dy(0)}{dt} = -5$ for $0 \leq t \leq 20$ using MATLAB and SIMULINK. Compare the computed solution with the analytical solution obtained.

4. Compute the solution for the following second-order difference equation:

$$y(n) - 0.25y(n-1) - 0.125y(n-2) = x(n) + 0.5x(n-1)$$

with initial conditions $y(-1) = 1$, $y(-2) = 2$ and input $x(n) = u(n) - u(n-3)$ using MATLAB and SIMULINK. Compare the computed solution with the analytical solution obtained.

5. Write M-file to determine the first 100 values of the step response $s(t)$ and $s(n)$ of the system given the impulse response $h(t)$ and $h(n)$ respectively.

6. Write M-file to determine the first 100 values of the impulse response $h(t)$ and $h(n)$ of the system given the step response $s(t)$ and $s(n)$ respectively.