ECE 580
Spring/Summer 2018
Computer Lab Assignment 2
Solving difference equations
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Objective:

In this exercise we learn how to solve constant-coefficient difference equation using Matlab. Also, we investigate the response of systems to different kinds of inputs.

(1) Consider the difference equation given as follows:

$$y(n) = 0.75y(n-1) - x(n) + \left(\frac{4}{3}\right) x(n-1),\ n \geq 0.$$

Find and plot $x(n)$ and $y(n)$ and hence find the energy of $y(n)$ for the following cases:

(a) $x(n) = \delta(n)$
(b) $x(n) = u(n-3)$
(c) $x(n) = u(n)u(-n+21)$
(d) $x(n) = r(n) - r(n-23)$, where $r(n)$ is the unit-ramp sequence.

(2) For the given difference equation:

$$y(n) = 0.3y(n-1) + 0.4y(n-2) + x(n) + 0.75x(n-1) - 2.5x(n-2),$$

find $y(n)$ for $x(n) = u(n)$, assuming the following initial conditions:

- $y(-1) = 4$
- $y(-2) = -10$.

(3) Consider the difference equation given as follows:

$$y(n) = 0.75y(n-2) + x(n) + 2x(n-1) - x(n-2).$$

(a) Draw the block diagram of the above difference equation in terms of adders, multipliers and delay blocks.
(b) Find the output $y(n)$ for an input $x(n) = \delta(n)$. What is this response called? Is the system stable?
(c) Find the response due to a unit-step input.
(d) Construct and plot the signal $x(n) = p_5(n-2) * p_{10}(n)$. Hence, using $x(n)$ as an input, find and plot the output $y(n)$.
(e) Determine the energy of the output signals for part (d).

(4) Consider the system described by the following difference equation:

$$y(n) = -1.77y(n-1) - 0.81y(n-2) + x(n) - 0.5x(n-1).$$

(a) Assuming a unit-step input, and using a long enough section of the input so that a constant output $y(n)$ is observed for large n, hence plot the output and determine the value of this constant called G_o.

Note: $G_o = y(n)$ for $n \longrightarrow \infty$.

(b) Determine and plot the transient response given by:

$$y_t(n) = y(n) - G_o.$$

(c) Find the energy of the transient response signal.

(d) After how many samples does the output reach steady-state? Write a Matlab program to determine the beginning of the steady-state (end of the transient) period.

(5) For the system described by the following difference equation:

$$y(n) = 0.9051y(n-1) - 0.598y(n-2) + 0.29y(n-3) - 0.1958y(n-4)$$

$$+0.207x(n) + 0.413x(n-2) + 0.207x(n-4).$$

(a) Plot the magnitude and phase responses of the above system. What is the type of this filter?

(b) (b) Find and plot the response of the system to the input signal given by:

$$x(n) = 8sin(\omega_1 n - \pi/3)cos(\omega_2 n - \pi/4)u(n), where\ \omega_1 = 0.25\pi\ and\ \omega_2 = 0.45\pi.$$

(c) Determine the steady-state output and hence find the transient response.

(d) After how any samples does the output reach steady state? Write a program to find the beginning of the steady-state period (end of transient period). Plot the transient response and calculate the energy of the transient signal.

(e) Plot the magnitude spectra of the input and output signals. Hence, comment on the results.