

SIGNALS AND SYSTEMS I

Computer Assignment 4

Exercises

For this assignment, use the discrete system described by the difference equation,

$$y[n] - 2r\cos(\omega_0)y[n - 1] + r^2y[n - 2] = r\sin(\omega_0)x[n - 1]$$

where $x(n)$ is the system's input, $y(n)$ is the system's output and

$$\omega_0 = \frac{\pi}{7}$$

1. Draw a Direct Form I block diagram of the system and determine the system's impulse response (zero-state response, or ZSR), $h[n]$. Show your work for credit.

(hint: $y[n = 0] = 1, y[n < 0] = 0, h[n] = h_{zeros}[n] * h_{poles}[n]$)

2. From Example 1, determine the values of r for which this system stable.

(hint: recall the Schwarz Inequality):

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

Show your work for credit.

- 3 Using a *for* loop or a *while* loop, write a program that implement your Direct Form I block diagram. Using this program, calculate the first 51 outputs of the system's impulse response when

i) $r = 0.99$

ii) $r = 1$

iii) $r = 1.01$.

Plot the input and the outputs using the **stem**, **title** and **subplot** functions. (You should generate 4 plots on 1 page.)

4. Using your program, calculate the first 51 outputs of the system's zero-input response (ZIR) when the system's initial conditions are $y(-1) = -r^{-1}\sin(\omega_0)$, $y(-2) = -r^{-2}\sin(2\omega_0)$ and

i) $r = 0.99$ ii) $r = 1$ iii) $r = 1.01$.

Plot the outputs using the **stem**, **title** and **subplot** functions. (You should generate 3 plots on 1 page). Compare (**max(abs(difference))**) with your result in Exercise 3.

5. Using your program, calculate the first 51 outputs of the system's impulse response when the system's initial conditions are $y(-1) = -r^{-1}\sin(\omega_0)$, $y(-2) = -r^{-2}\sin(2\omega_0)$ and:

- i) $r = 0.99$
- ii) $r = 1$
- iii) $r = 1.01$.

Plot the input and the outputs using the **stem**, **title** and **subplot** functions. (You should generate 4 plots on 1 page.)

6. Add your results from Exercises 3 and 4 and compare them to your results in Exercise 5. Comment on your comparison.