ECE 438 Lab 2 Report
David Dang & Benedict Lee

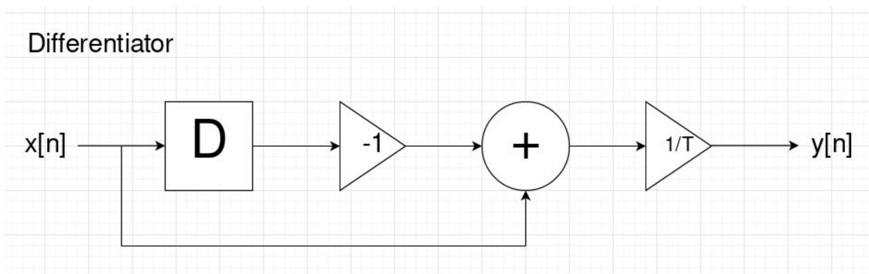
2 Example of Discrete-time Systems

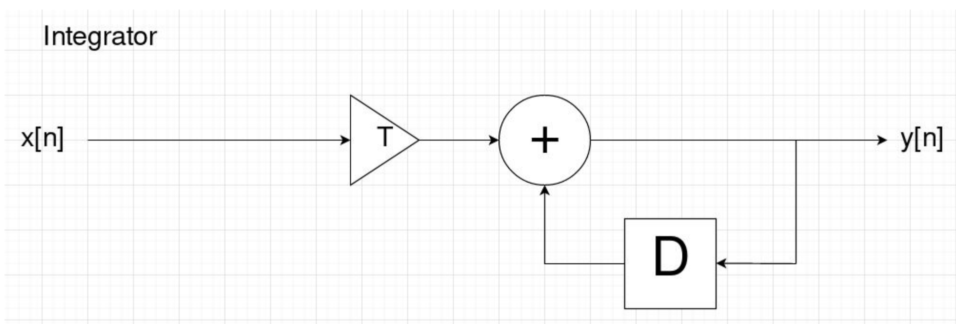
INLAB REPORT: For each of these two systems, do the following:

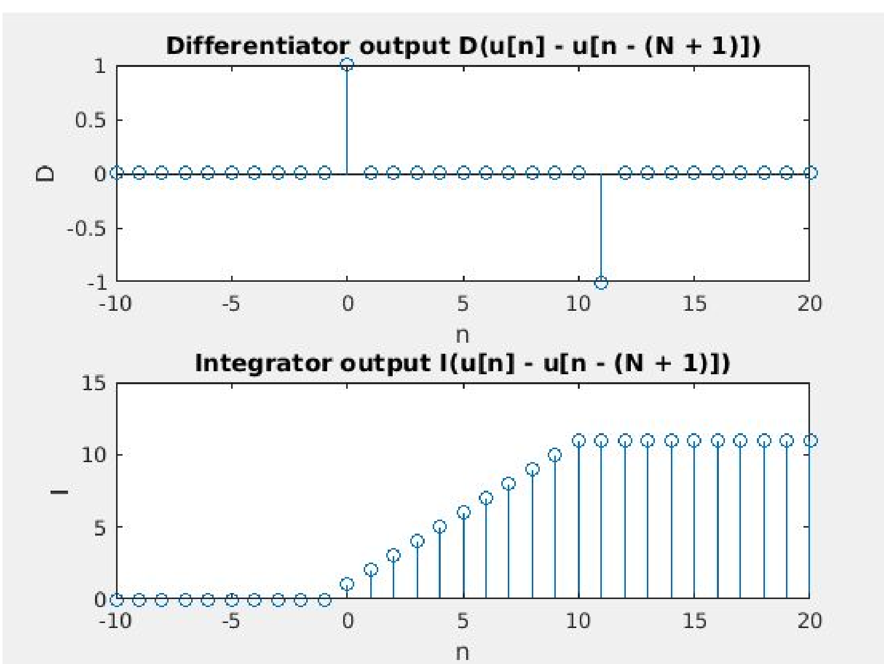
i. Draw block diagrams of both the discrete-time differentiator and integrator as in Fig. 1.

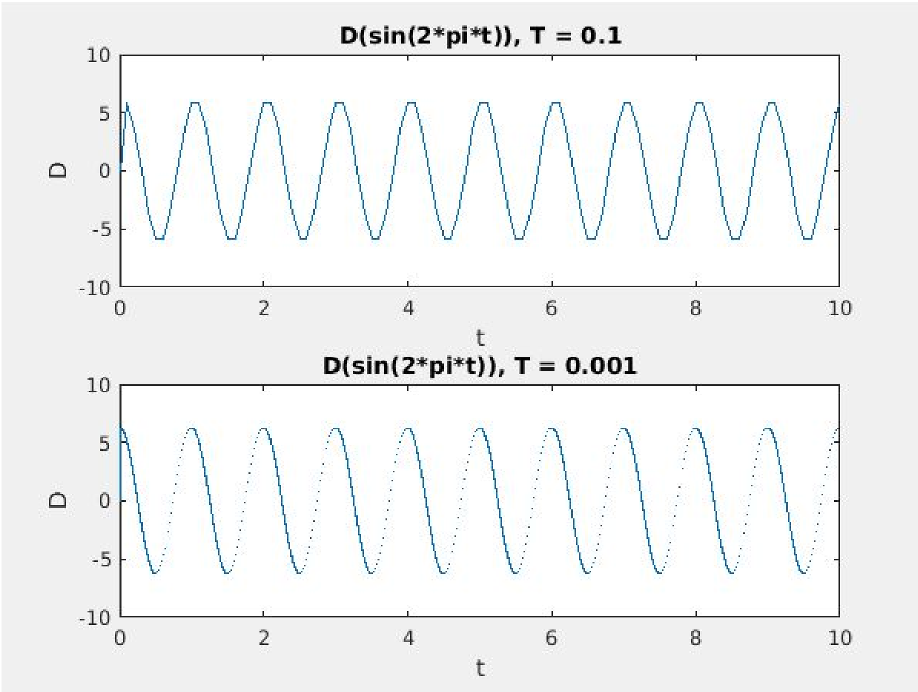
ii. Apply both the discrete-time differentiator and integrator to the signal $u[n]-u[n-(N+1)]$, with $N= 10$, for $-10 \leq n \leq 20$. (This assumes a time-step of $T= 1$)

iii. Use the discrete-time differentiator to numerically evaluate $\frac{d}{dt}x(t)$ of $x(t) = \sin(2\pi t)$ for $t \in [0,10]$, try $T= 0.1$ and $T= 0.001$ and compare the results. You can use SIMULINK if you know how.





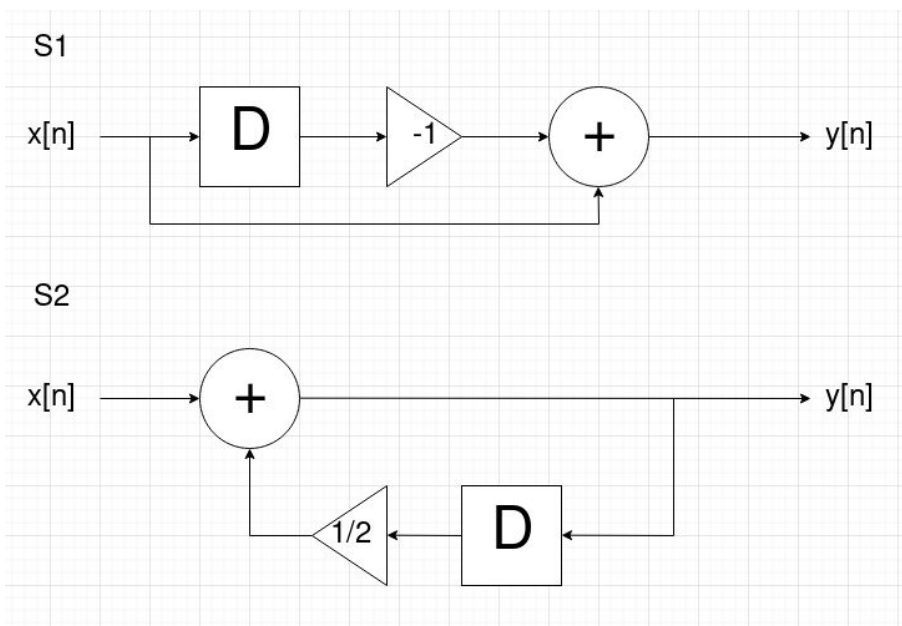


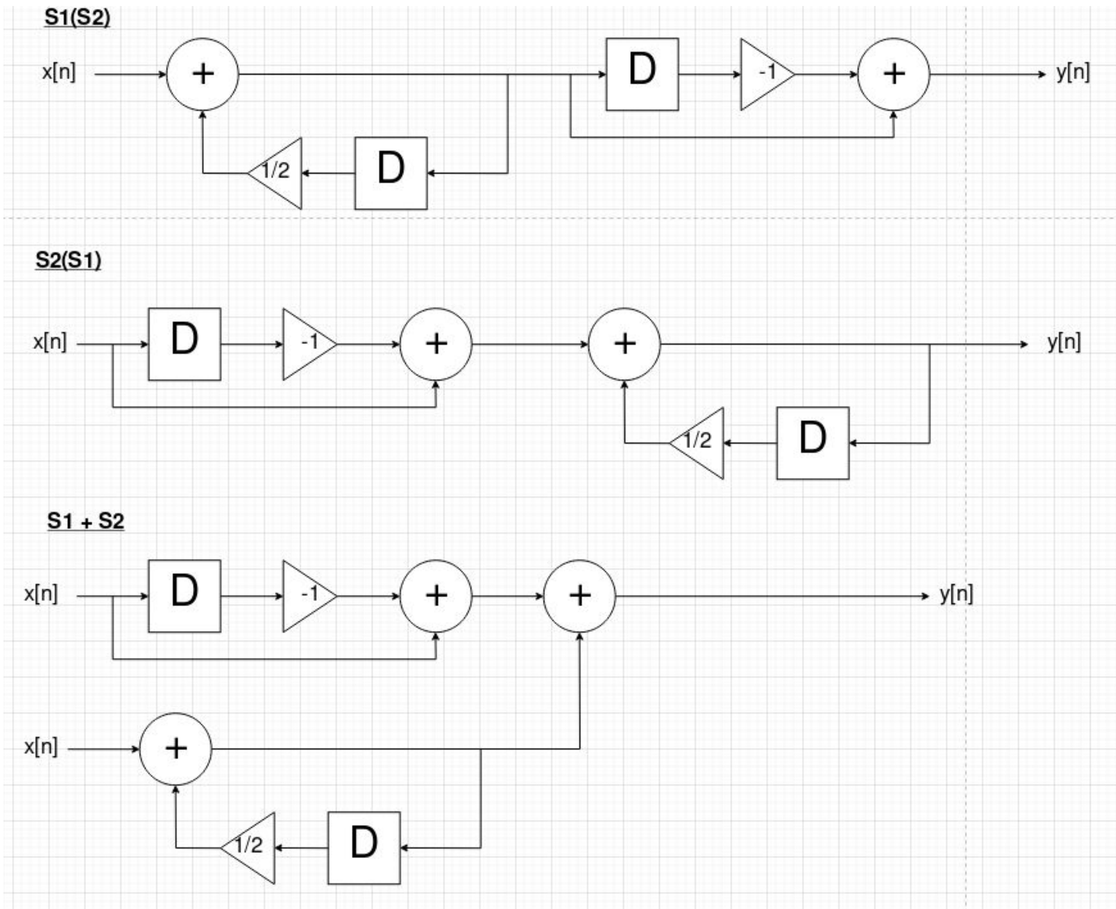


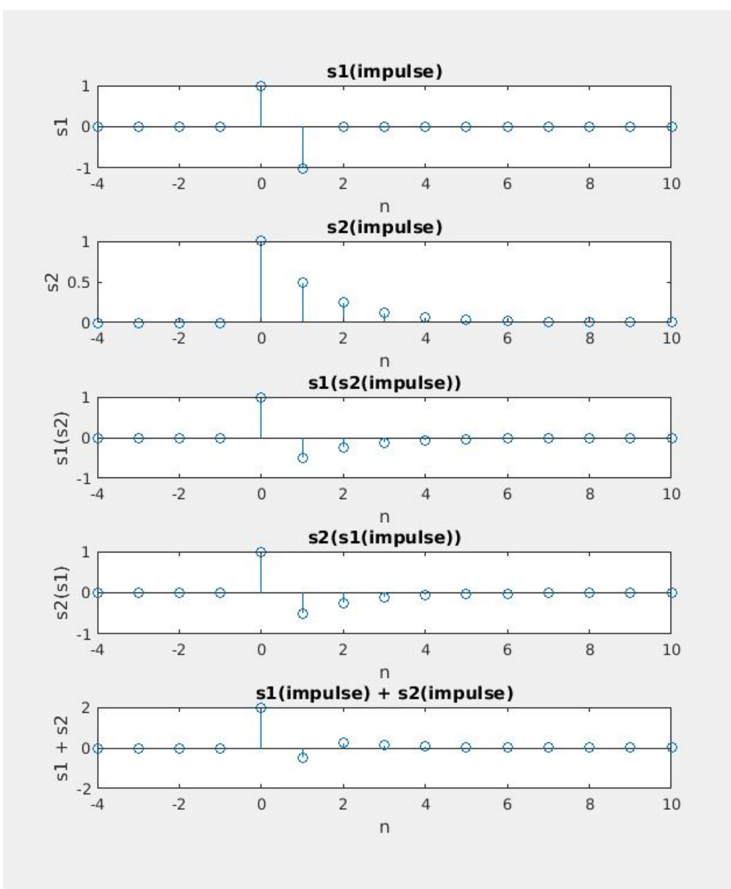
- When T = 0.001, the derivative became smoother than when T = 0.1

3 Difference Equations

INLAB REPORT: For each of the five systems, draw and submit a system diagram (use only delays, multiplications and additions as in Fig. 1). Also submit plots of each impulse response. Discuss your observations.

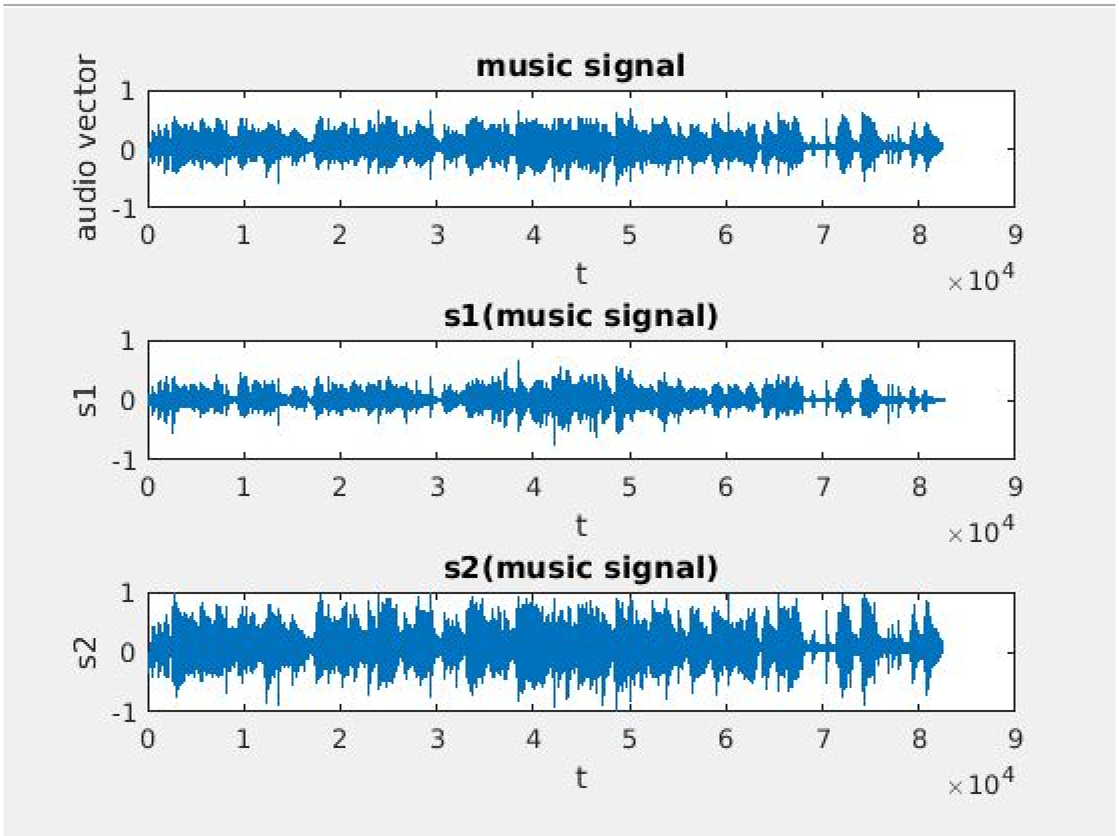






- S1 flips the impulse at n = 1 and then becomes 0 after that. S2 takes the impulse and divides it by 2 for increasing n. s1(s2) takes the impulse, halves it for increasing n, and then inverts it. s2(s1) is the same as s1(s2), except the steps are reversed. S1 + s2 adds the inverted impulse at n = 1 from s1 to the halved impulse from s2 at n = 1.

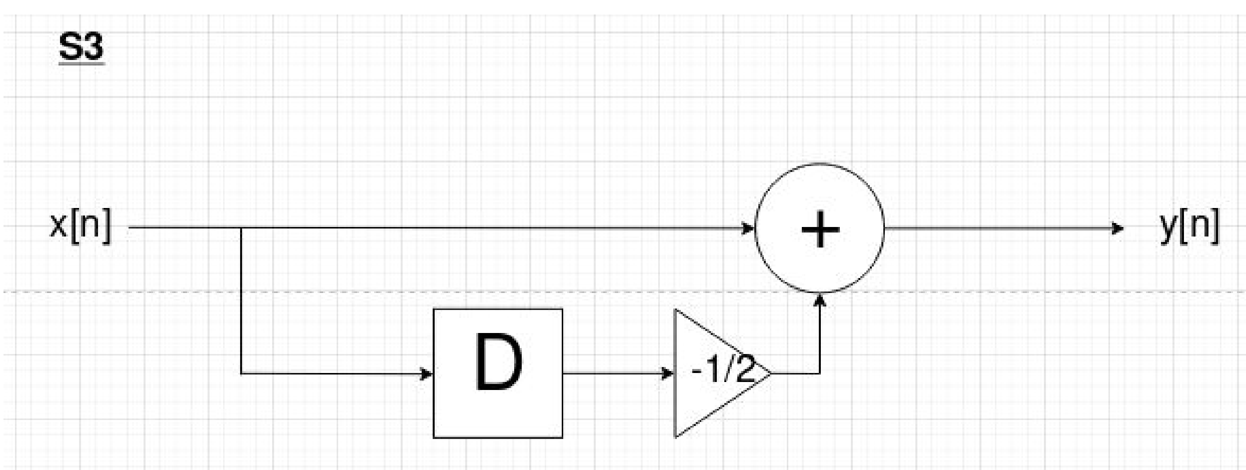
INLAB REPORT: How do the filters change the sound of the audio signals? Explain your observations.

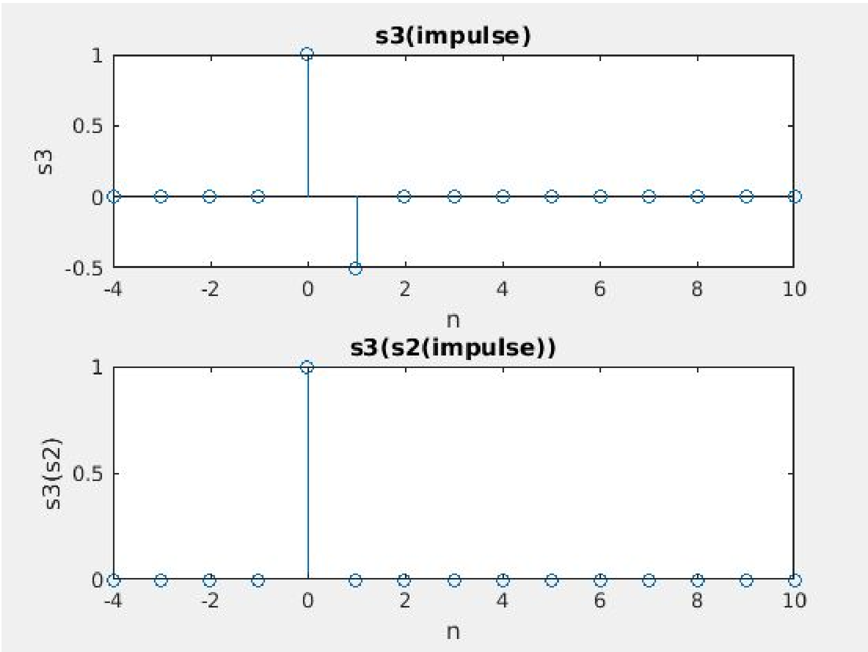


- S1 makes the audio sharper while s2 makes the audio sound deeper

4 Inverse Systems

INLAB REPORT: Draw a system diagram for the system S_3, and submit plots of the impulse responses for S_3 and $S_3(S_2)$.





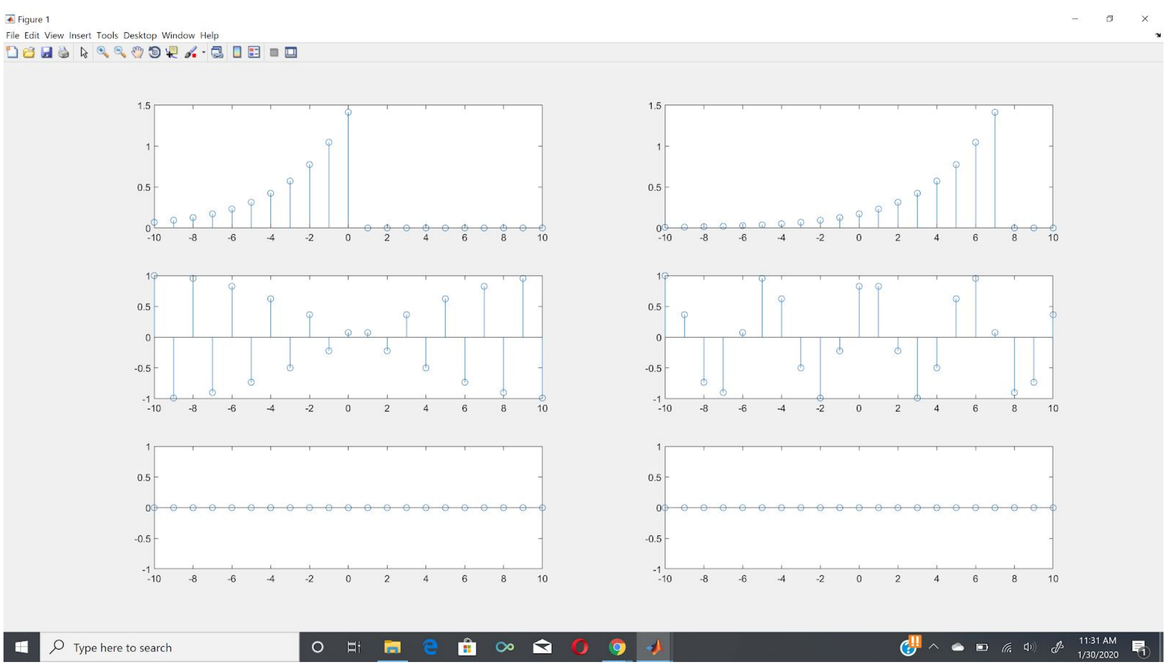
5 System Tests

INLAB REPORT:

•State which system is non-linear, and which system is time-varying.

•Submit plots of input/output signal pairs that support your conclusions.

•Indicate on the plots why they support your conclusions.



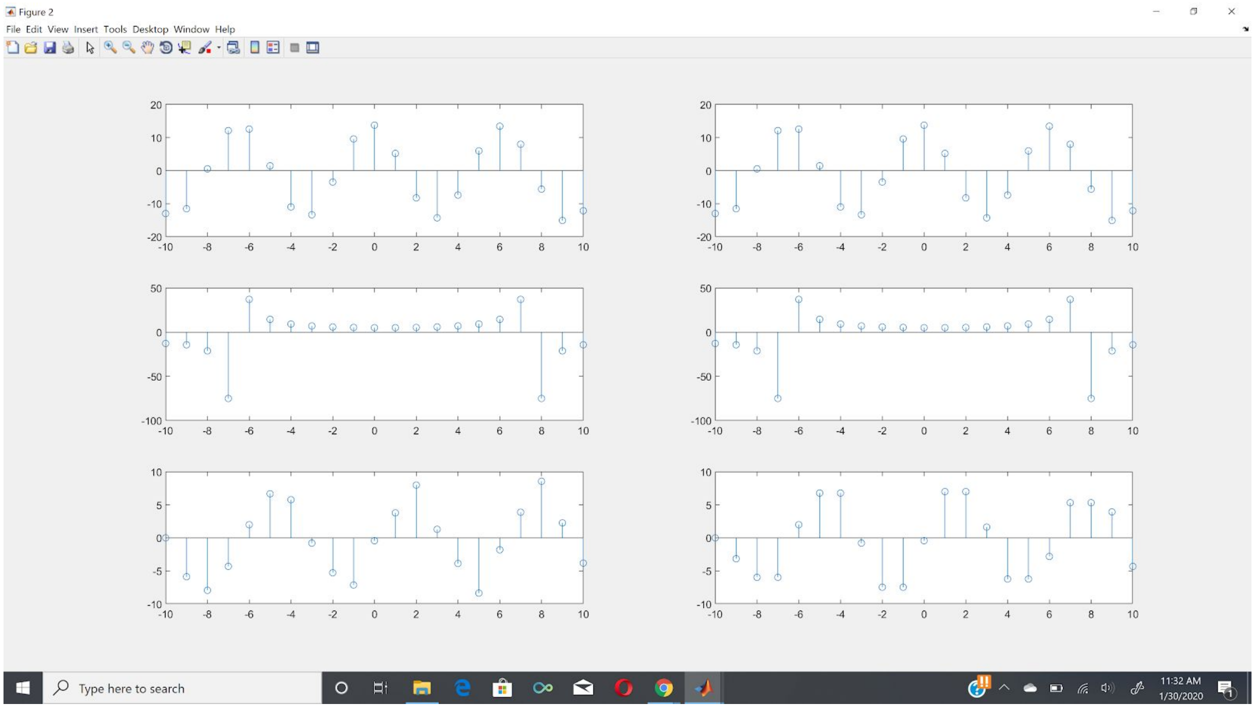


Figure 2
File Edit View Insert Tools Desktop Window Help
Type here to search
11:32 AM
1/30/2020

- The time varying system was found to be bbox2 and the non-linear system was found to be bbox3. For bbox2, the inputs to the system were u(t), u(t - 0.5), and u(t - 1). For a time invariant system, the outputs should be the same for each shifted signal, but as one would notice, the output changes every time it shifts, so it's time varying. For bbox3, the inputs to the system were y1 = 4*sin(t) and y2 = mod(t, (2*pi)) / pi. For a linear system, bbox3(y1 + y2) = bbox3(y1) + bbox3(y2), but they are not quite the same since bbox3(y1) + bbox3(y2) is sharper at t = 0 & t = 5 than bbox3(y1 + y2).

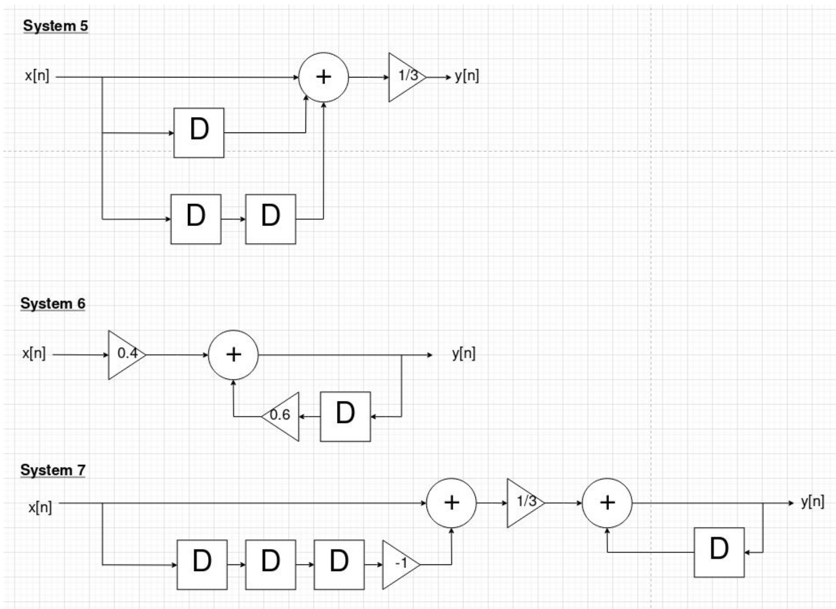
6 Stock Market Example

INLAB REPORT:

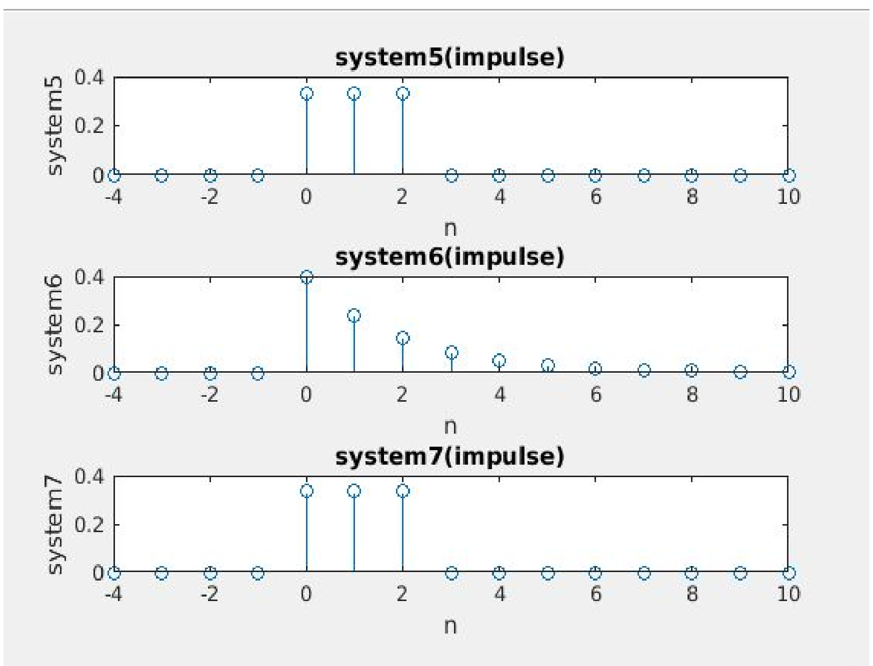
•For each of these three methods, 1) write a difference equation, 2) draw a system diagram, and 3) calculate the impulse response.
•Explain why methods (5) and (7) are known as moving averages.

1) y[n] = (1/3)*(x[n] + x[n - 1] + x[n - 2]) (system 5)
   y[n] = 0.6*(y[n - 1]) + 0.4*(x[n]) (system 6)
   y[n] = y[n - 1] + (1/3)*(x[n] - x[n - 3])
   (system 7)

2)



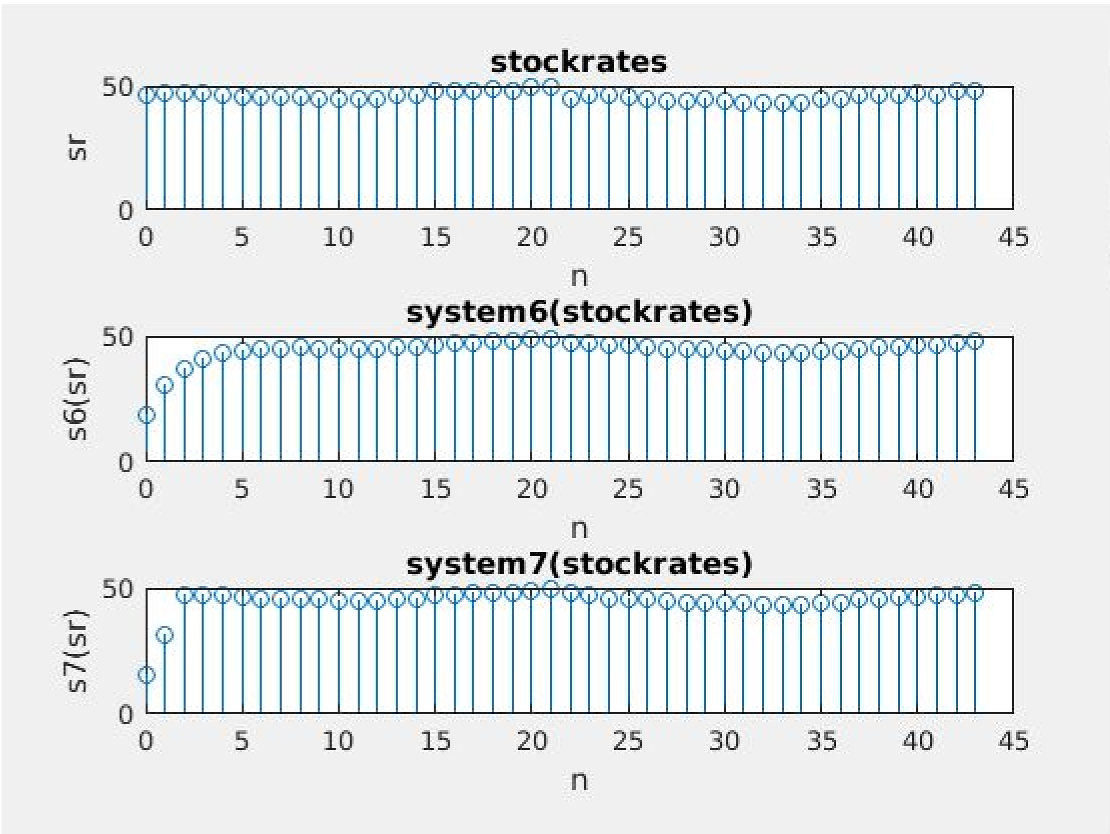
3)



- Systems 5 & 7 are known as moving averages because they calculate the average for every three values of n. Every time n increases, a new value (x[n]) comes in and another value (x[n-2]) is discarded. A new average is calculated for every three n.

6.2 Application

INLAB REPORT: Submit your plots of the original and filtered exchange-rates. Discuss the advantages and disadvantages of the two filters. Can you suggest a better method for initializing the filter outputs?



- Since matlab uses indexing starting at 1, initialize the filter output based on the difference equation. That is, for y[n] = y[n - 1] + (1/3)*(x[n] - x[n - 3]), you need to initialize the first three output of the filter because the output relies on three previous values
  (e.g. y(1) = (1/3)*x(1),
  y(2) = y(1) + (1/3)*x(2),
  y(3) = y(2) + (1/3)*x(3))