Homework # 2

(Due Date: June 20th @ 2pm)
Presentation is very important!

PROBLEM 1 (24 PTS)

Evaluate the DT convolution: $y[n] = x[n]*h[n]$ for the following cases:

a)	$x[n] = u[n] - u[n-8]$	$h[n] = (1/4)(u[n] - u[n-5])$
b)	$x[n] = 3^n u[-n+4]$	$h[n] = u[n-3]$
c)	$x[n] = u[n+2]$	$h[n] = u[n-2]$
d)	$x[n] = \sin(\pi n)u[n]$	$h[n] = u[n-1]$
e)	$x[n] = (1/2)^n u[n]$	$h[n] = u[n+1]$
f)	$x[n] = u[n+10] - 2u[n]$	$h[n] = \alpha^n u[n],\ \lvert\alpha\rvert < 1$

PROBLEM 2 (16 PTS)

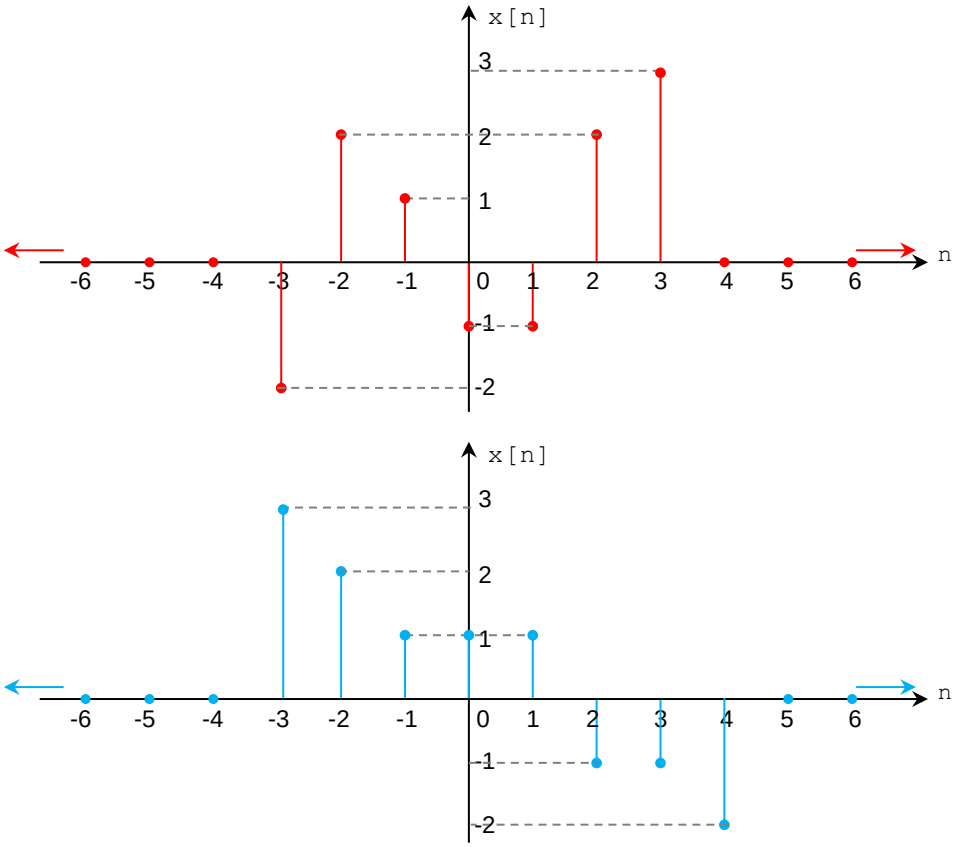
Evaluate the CT convolution: $y(t) = x(t)*h(t)$ for the following cases:

a)	$x(t) = u(t-1) - u(t-3)$	$h(t) = u(t) - u(t-4)$
b)	$x(t) = \sin(\pi t)(u(t+1) - u(t-1))$	$h(t) = u(t) - u(t-3)$
c)	$x(t) = e^{-3t} u(t)$	$h(t) = u(t+2)$
d)	$x(t) = e^{-2t} (u(t+2) - u(t-2))$	$h(t) = u(t) - u(t-2)$

PROBLEM 3 (10 PTS)

Given the following system: $y[n] = x[n] + 2x[n-1] + 3x[n-2] + 2x[n-3] + x[n-4]$

a) Apply $\delta[n]$ to the input and obtain the impulse response $h[n]$. Carefully sketch $h[n]$. (3)
b) With the impulse response $h[n]$, you can obtain the output for any input signal $x[n]$. Carefully sketch the output signal $y[n]$ for the following input signals. You MUST show the convolution procedure. (7)



PROBLEM 4 (20 PTS)

A system (called Moving-Average) has the following input-output relationship:

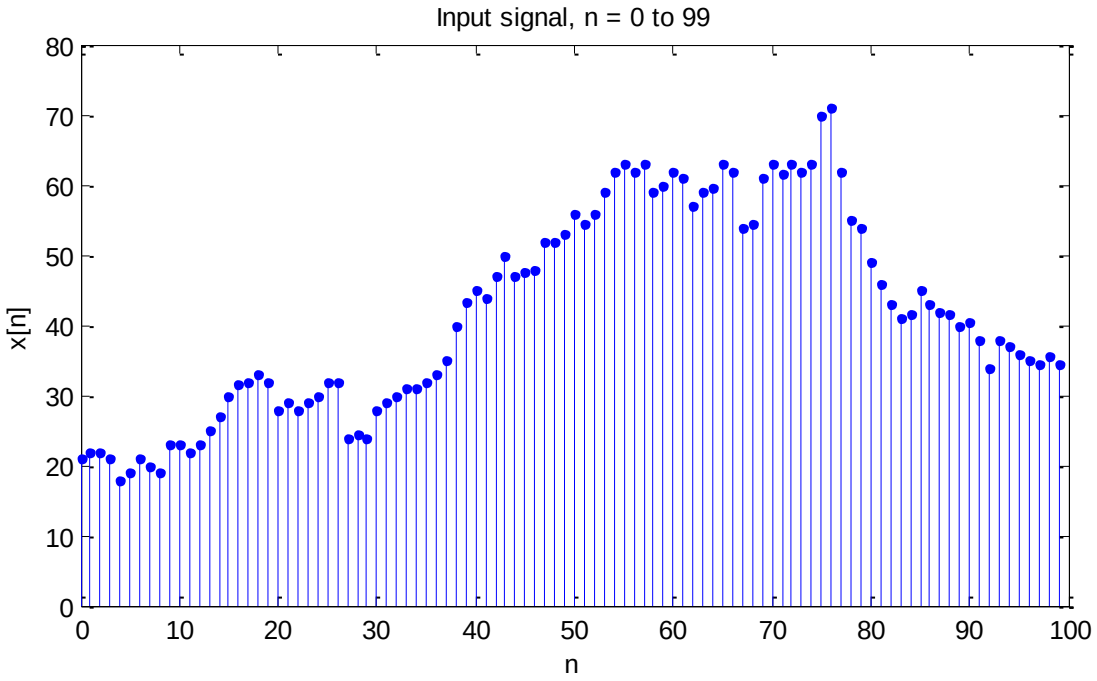
$$y[n] = \frac{1}{N}\sum_{k=0}^{N-1} x[n-k]$$

a) Obtain the equation of the impulse response `h[n]`. Sketch `h[n]`. (3)

b) Using MATLAB®, plot the response of the system to the input signal below when i) N = 2, ii) N = 5, and iii) N = 10. For each case, explicitly indicate the range of indices for `y[n]`. Attach your MATLAB code to the plots. (15)

c) In your words, explain what effect N has on the shape of the output signal y[n]. (2)
Note: The values of the index `n` go from 0 to 99.

```
x = [21 22 22 21 18 19 21 20 19 23 23 22 23 25 27 30 31.5 32 33 32 ...
     28 29 28 29 30 32 32 24 24.5 24 28 29 30 31 31 32 33 35 40 43.2 ...
     45 44 47 50 47 47.5 48 52 52 53 56 54.5 56 59 62 63 62 63 59  ...
     60 62 61 57 59 59.6 63 62 54 54.5 61 63 61.5 63 62 63 70 71 62 ...
     55 54 49 46 43 41 41.5 45 43 42 41.5 40 40.5 38 34 38 37 36 35 ...
     34.5 35.5 34.5];
```



PROBLEM 5 (12 PTS)

For each of the following impulse responses, determine whether the corresponding LTI system is:

(i) memoryless,
(ii) causal,
(iii) stable.

Justify your answers.

a) `h(t) = sin(πt)`
b) $h(t) = e^{-3t}u(t-2)$
c) $h(t) = 2\delta(t)$
d) $h[n] = (-1)^n u[-n]$
e) `h[n] = 3u[n-1] - 2u[n-4]`
f) `h[n] = cos(πn)(u[n-2] - u[n+2])`

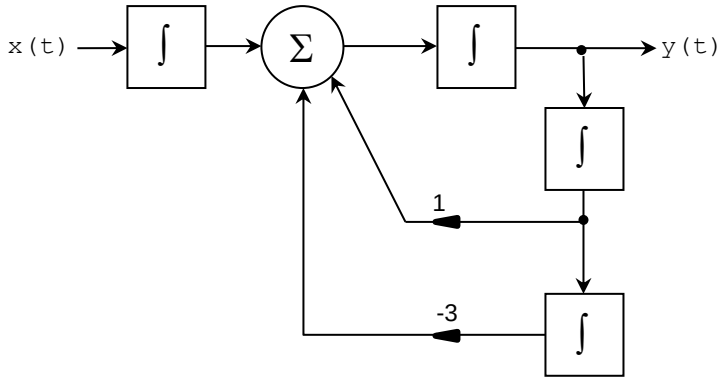
PROBLEM 6 (8 PTS)

Draw the direct form I and direct form II implementation for the following difference equations:

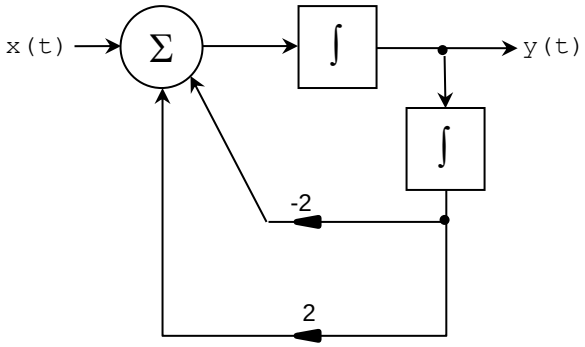
a) y[n] - (1/2)y[n-1] = 3x[n] - 2x[n-1]
b) y[n] + (1/4)y[n-1] - y[n-3] + (1/2)y[n-4] = x[n-1] - 2x[n-2]
c) y[n] - (1/8)y[n-2] = 4x[n-2]
d) y[n] - (1/3)y[n-1] = x[n] - x[n-2]

PROBLEM 7 (10 PTS)

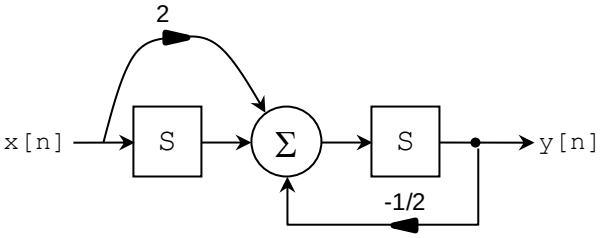
Find the differential-equation or difference-equation description for each of the systems depicted below:



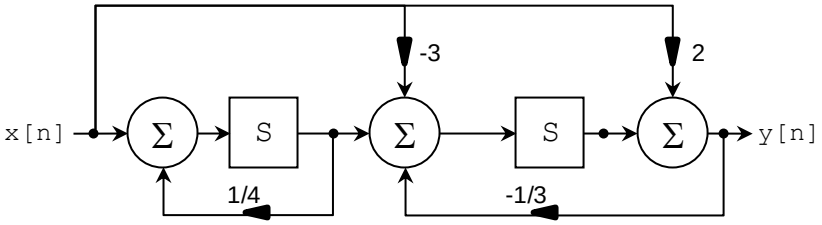
(a)



(b)



(c)



(d)