- Discrete-Time Linear Time-Invariant Systems
  - The convolution sum
- Continuous-Time Linear Time-Invariant Systems
  - The convolution integral
- Properties of Linear Time-Invariant Systems
- Causal Linear Time-Invariant Systems Described by Differential & Difference Equations
- Singularity Functions

Problem 2.38, 2.39 (p.148) – Block Diagram [SS2:86]

2.38. Draw block diagram representations for causal LTI systems described by the following difference equations:

(a) $y[n] = \frac{1}{3}y[n-1] + \frac{1}{2}x[n]$

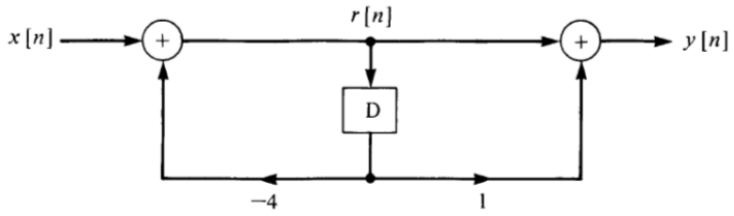
(b) $y[n] = \frac{1}{3}y[n-1] + x[n-1]$

2.39. Draw block diagram representations for causal LTI systems described by the following differential equations:

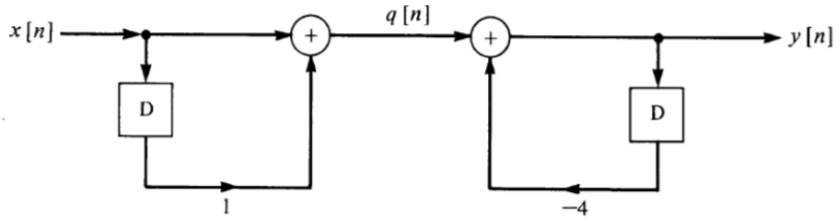
(a) $y(t) = -(\frac{1}{2})\,dy(t)/dt + 4x(t)$

(b) $dy(t)/dt + 3y(t) = x(t)$

5. (10%) Consider the following block diagram. Assume that the system is linear and time-invariant and initially at rest.



a) (3%) Show that the above diagram is equivalent to the following block diagram:



b) (4%) Find the difference equation relating $x[n]$ and $y[n]$.

c) (3%) Find $r[n]$, for all n if $x[n]=\delta[n]$.

7. (12%) Consider that the input and output of an LTI system are related by the following linear constant coefficient differential equation (LCCDE):

$$\frac{d^2y(t)}{dt^2}+4\frac{dy(t)}{dt}+3y(t)=\frac{dx(t)}{dt}+2x(t)$$

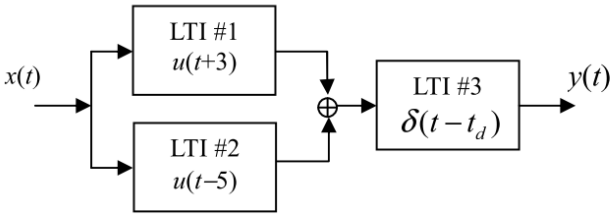
a) Find the impulse response $h(t)$ of the LTI system. (3%)

b) Is this system causal ? Justify your answer. (3%)

c) Is this system stable ? Justify your answer. (3%)

d) Find the output $y(t)$ of the LTI system when the input signal $x(t) = e^{-t}u(t)$, where $u(t)$ is the unit step function. (3%)

2. [12] The following block diagram depicts two LTI subsystems in parallel that are cascaded with a third LTI sub system. The impulse response of each subsystem is written within each block of the diagram.



(a) What is the impulse response of the overall system? [4]
(b) What should the time delay t_d be chosen so that the overall system is causal? [4]
(c) Which subsystems are stable? Is the overall system stable? [4]

5. [10] Let an LTI system have its input $x[n]$ and output $y[n]$ characterized by the following difference equation

$$y[n] - y[n\text{-}1]/2 = x[n]$$

with the condition of initial rest.
(a) Find the unit impulse response of the system. [6]
(b) Is this system stable? Justify your answer. [4]