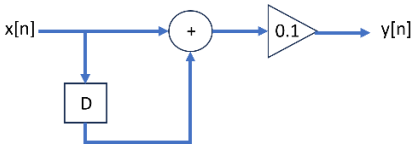
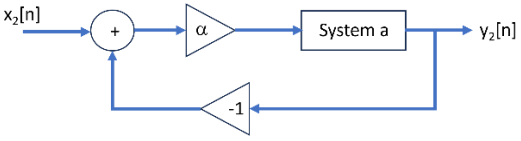
Signal Processing **Assignment- 2** Monsoon 2023

1. For the 2 block diagrams given below, write the corresponding ordinary difference equations (ODE) and operator forms for each of them.





System a is the system in the block diagram on the left.

2. Consider these first order systems: (i) $Y = \frac{R}{1-\alpha R}X$, (ii) $Y = \frac{1-\beta R}{1-\alpha R}X$
   a. Write the ODE for these systems.
   b. Draw the block diagram for these systems.
   c. Find and sketch the impulse response of these systems.
   d. Summarise your learning from the above answers. Specifically, state the advantage, if any, between these systems and the standard *accumulator* in terms of system behaviour.

3. Using convolution, find and sketch the response of the following systems.
   a. $x[n] = h[n] = u[n]$
   b. $x[n] = (\frac{1}{2})^n u[n]; h[n] = u[n].$
   c. $x[n] = (\frac{1}{2})^n u[n]; h[n] = sin\frac{n\pi}{25}(u[n] - u[n-10]).$
   d. Identify the function performed by the systems in parts a through c.

4. Correlation is a popular signal processing operation. Given two real sequences $f[m]$, g[m] the cross-correlation function $r_{f,g}[l]$ is defined as

$$r_{f,g}[l] = \sum_{m=-\infty}^{\infty} f[l+m]g[m];\ l \text{ is called the lag parameter}$$

   a. Find the cross-correlation function if $f[n]$ is a unit height sequence starting at n = 0 and is of length 4, and $g[n] = \delta[n+1]-2\delta[n]+\delta[n-1]$.
   b. When f[m] = g[m] in the above equation the operation is called autocorrelation. Find the autocorrelation functions $r_{f,f}[l]$ and $r_{g,g}[l]$. What can you observe from the results?
   c. Since correlation is a measure of similarity, what information do the cross-correlation and autocorrelation functions help extract?
   d. The correlation operation is very similar to the convolution operation. Derive the relation between the two.