Question 2

Part a)

The frequency response of the system 1 which is described by $y[n] = x[n-3]$ is given in the Figure 1. Observing the magnitude response of the system 1, it can be said that it is an all pass system since it doesn't filter out any frequencies. However, it changes the phases of the input since it has a non zero phase response; but since it has a linear phase response, it doesn't disturb the input signal.

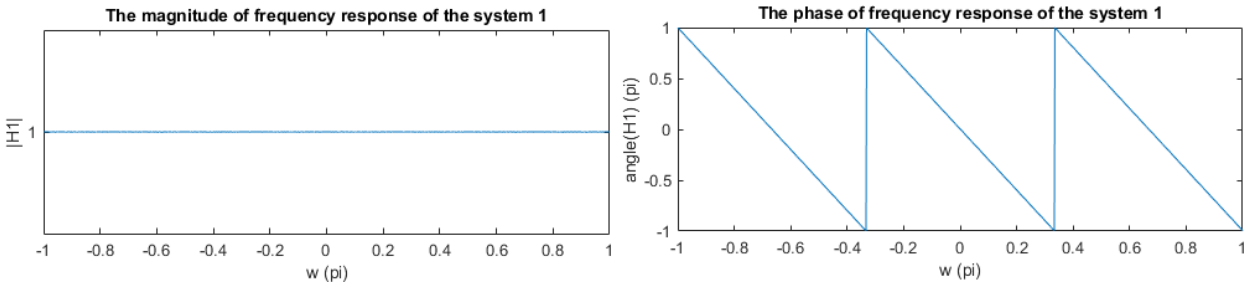

Figure 1: The frequency response of the system 1

Part b)

The frequency response of the system 2 which is described by $y[n] - \frac{3}{4}y[n-1] = -\frac{3}{4}x[n] + x[n-1]$ is given in the Figure 2. It is not expected to obtain the same outputs from the system 1 and 2, since their phase responses are not identical yet their magnitude responses are the same.

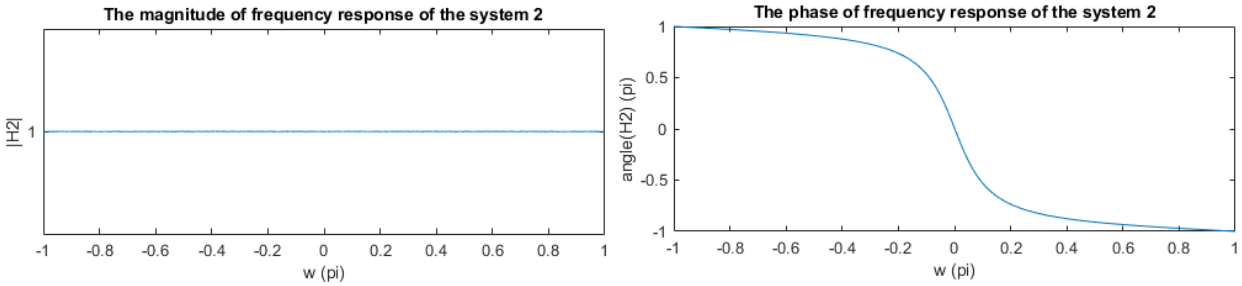

Figure 2: The frequency response of the system 2

Part c)

The input $x[n] = (\frac{3}{4})^n u[n]$ is given in the Figure 3.

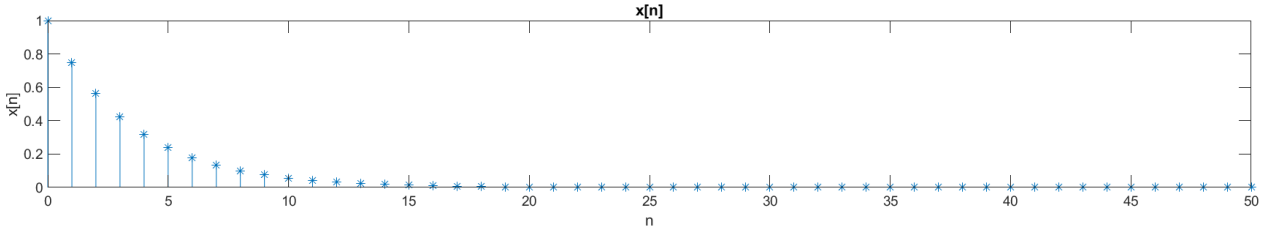

Figure 3: The input $x[n]$

Part d)

The respective outputs $y_1[n]$ and $y_2[n]$ of systems 1 and 2 in response to $x[n]$ are given in the Figure 4. As seen from the Figure 4 that their responses are different since their phase responses aren't identical yet their magnitude responses are identical.

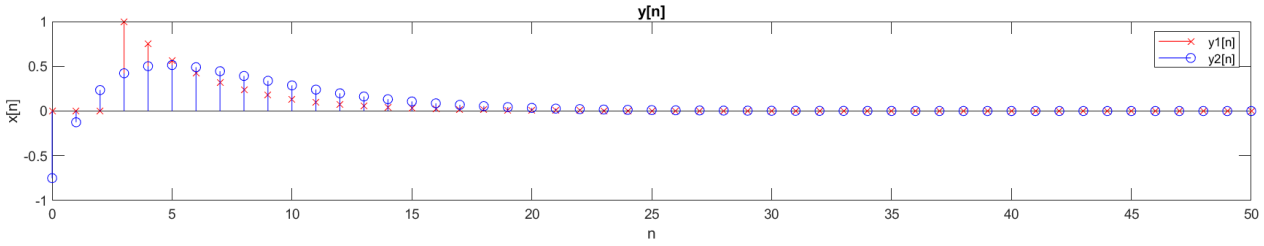

Figure 4: The outputs of the system 1 and 2 in response to $x[n]$

Part e)

The magnitudes of the DTFT of the $x[n]$, $y_1[n]$, and $y_2[n]$ are given in the Figure 5. Since both systems have unity in their magnitude response, they don't disturb the magnitudes of the DTFT of the input $x[n]$; so, it cannot be determined which response belongs which system, since they are the same. To distinguish them, their phases of the DTFT should be analyzed. However, preserving the magnitude of the DTFT doesn't mean that the signal is not distorted in the time domain. This outcome can be seen in the Figure 4 that the system 2 distorts the input $x[n]$, whereas the system 2 just shifts the input $x[n]$ by 3 units, namely delays by 3 units.

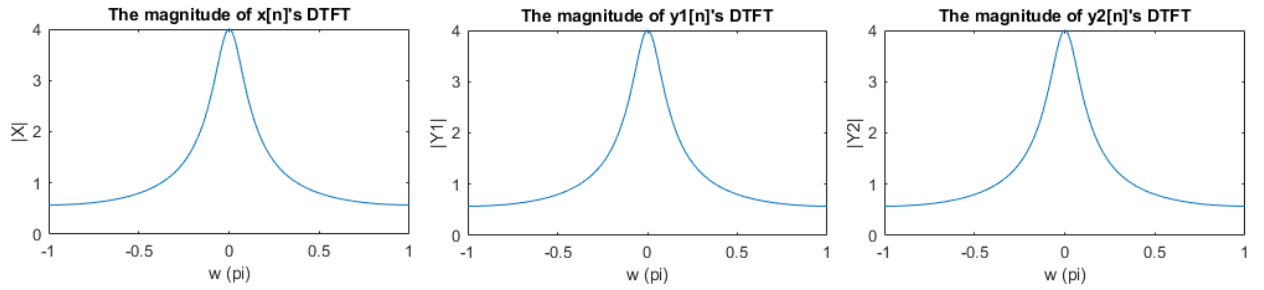

Figure 5: The magnitudes of the DTFT of the $x[n]$, $y_1[n]$, and $y_2[n]$

Part f)

If the input $x[n]$ is given to the system which is the cascade of system 2 with itself, $|Y_{22}(e^{jw})|$, the DTFT of the output will be equal to $|X(e^{jw})|$; since the magnitude response of the system 2 is unity. However, their phases of DTFT won't be the same, the cascaded system will distort the input signal in the time domain. The output in the time domain will be even more distorted and start to oscillate if arbitrary number of System 2s are cascaded, however, since the cascade of the system 2 gives also unity in magnitude response, the magnitude response of the overall system will be unity as well.