1-

```
A=[1,2,1;6,1,3;7,7,3]
Determinant=p1(A)
```

```
A = 3x3
     1     2     1
     6     1     3
     7     7     3

Determinant = 23
```

2-

```
A=[1,2,1;6,1,3;7,7,3]
inverse=p2(A)
```

```
A = 3x3
     1     2     1
     6     1     3
     7     7     3

inverse = 3x3
   -0.7826    0.0435    0.2174
    0.1304   -0.1739    0.1304
    1.5217    0.3043   -0.4783
```

3-

$$y[n] = \sum_{m} x[n-m] \times h[m]$$

$$for\ n \leq 1: y[n] = 0$$

$$y[2] = \sum_{m} x[2-m] \times h[m] = x[1] \times h[1] = 2 \times 5 = 10$$

$$y[3] = \sum_{m} x[3-m] \times h[m] = x[1] \times h[2] + x[2] \times h[1] = -6$$

$$y[4] = \sum_{m} x[4-m] \times h[m] = x[1] \times h[3] + x[2] \times h[2] + x[3] \times h[1] = 39$$

$$y[5] = x[1] \times h[4] + x[2] \times h[3] + x[3] \times h[2] + x[4] \times h[1] = -21$$

$$y[6] = x[1] \times h[5] + x[2] \times h[4] + x[3] \times h[3] + x[4] \times h[2] + x[5] \times h[1] = 54$$

$$y[7] = x[1] \times h[6] + x[2] \times h[5] + x[3] \times h[4] + x[4] \times h[3] + x[5] \times h[2] + x[6] \times h[1] = -38$$

$$\begin{aligned} y[8] = {} & x[1] \times h[7] + x[2] \times h[6] + x[3] \times h[5] + x[4] \times h[4] + x[5] \times h[3] + x[6] \times h[2] \\ & + x[7] \times h[1] = 21 \end{aligned}$$

$$\begin{aligned} y[9] = {} & x[1] \times h[8] + x[2] \times h[7] + x[3] \times h[6] + x[4] \times h[5] + x[5] \times h[4] + x[6] \times h[3] \\ & + x[7] \times h[2] + x[8] \times h[1] = 5 \end{aligned}$$

$$\begin{aligned} y[10] = {} & x[1] \times h[9] + x[2] \times h[8] + x[3] \times h[7] + x[4] \times h[6] + x[5] \times h[5] + x[6] \times h[4] \\ & + x[7] \times h[3] + x[8] \times h[2] + x[9] \times h[1] = -81 \end{aligned}$$

$$\begin{aligned} y[11] = {} & x[1] \times h[10] + x[2] \times h[9] + x[3] \times h[8] + x[4] \times h[7] + x[5] \times h[6] + x[6] \times h[5] \\ & + x[7] \times h[4] + x[8] \times h[3] + x[9] \times h[2] + x[10] \times h[1] = 76 \end{aligned}$$

$$\begin{aligned} y[12] = {} & x[1] \times h[11] + x[2] \times h[10] + x[3] \times h[9] + x[4] \times h[8] + x[5] \times h[7] + x[6] \times h[6] \\ & + x[7] \times h[5] + x[8] \times h[4] + x[9] \times h[3] + x[10] \times h[2] + x[11] \times h[1] = 15 \end{aligned}$$

$$\begin{aligned} y[13] = {} & x[1] \times h[12] + x[2] \times h[11] + x[3] \times h[10] + x[4] \times h[9] + x[5] \times h[8] + x[6] \times h[7] \\ & + x[7] \times h[6] + x[8] \times h[5] + x[9] \times h[4] + x[10] \times h[3] + x[11] \times h[2] \\ & + x[12] \times h[1] = -58 \end{aligned}$$

$$\begin{aligned} y[14] = {} & x[1] \times h[13] + x[2] \times h[12] + x[3] \times h[11] + x[4] \times h[10] + x[5] \times h[9] + x[6] \times h[8] \\ & + x[7] \times h[7] + x[8] \times h[6] + x[9] \times h[5] + x[10] \times h[4] + x[11] \times h[3] \\ & + x[12] \times h[2] + x[13] \times h[1] = 120 \end{aligned}$$

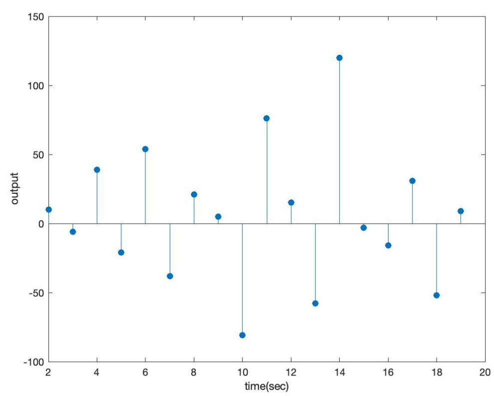
$$\begin{aligned} y[15] = {} & x[1] \times h[14] + x[2] \times h[13] + x[3] \times h[12] + x[4] \times h[11] + x[5] \times h[10] + x[6] \times h[9] \\ & + x[7] \times h[8] + x[8] \times h[7] + x[9] \times h[6] + x[10] \times h[5] + x[11] \times h[4] \\ & + x[12] \times h[3] + x[13] \times h[2] + x[14] \times h[1] = -3 \end{aligned}$$

$$
\begin{aligned}
y[16] = \; & x[1] \times h[15] + x[2] \times h[14] + x[3] \times h[13] + x[4] \times h[12] + x[5] \times h[11] + x[6] \times h[10] \\
& + x[7] \times h[9] + x[8] \times h[8] + x[9] \times h[7] + x[10] \times h[6] + x[11] \times h[5] \\
& + x[12] \times h[4] + x[13] \times h[3] + x[14] \times h[2] + x[15] \times h[1] = -16
\end{aligned}
$$

$$
\begin{aligned}
y[17] = \; & x[1] \times h[16] + x[2] \times h[15] + x[3] \times h[14] + x[4] \times h[13] + x[5] \times h[12] + x[6] \times h[11] \\
& + x[7] \times h[10] + x[8] \times h[9] + x[9] \times h[8] + x[10] \times h[7] + x[11] \times h[6] \\
& + x[12] \times h[5] + x[13] \times h[4] + x[14] \times h[3] + x[15] \times h[2] + x[16] \times h[1] = 31
\end{aligned}
$$

$$
\begin{aligned}
y[18] = \; & x[1] \times h[17] + x[2] \times h[16] + x[3] \times h[15] + x[4] \times h[14] + x[5] \times h[13] + x[6] \times h[12] \\
& + x[7] \times h[11] + x[8] \times h[10] + x[9] \times h[9] + x[10] \times h[8] + x[11] \times h[7] \\
& + x[12] \times h[6] + x[13] \times h[5] + x[14] \times h[4] + x[15] \times h[3] + x[16] \times h[2] \\
& + x[17] \times h[1] = -52
\end{aligned}
$$

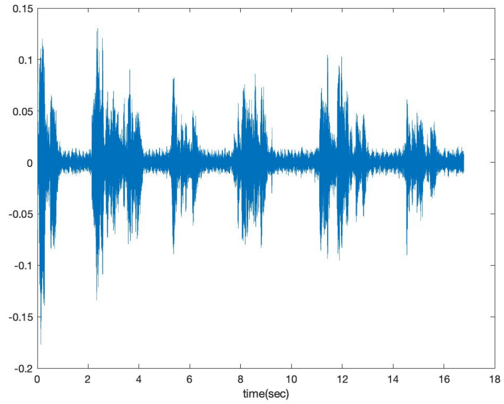
$$
\begin{aligned}
y[19] = \; & x[1] \times h[18] + x[2] \times h[17] + x[3] \times h[16] + x[4] \times h[15] + x[5] \times h[14] + x[6] \times h[13] \\
& + x[7] \times h[12] + x[8] \times h[11] + x[9] \times h[10] + x[10] \times h[9] + x[11] \times h[8] \\
& + x[12] \times h[7] + x[13] \times h[6] + x[14] \times h[5] + x[15] \times h[4] + x[16] \times h[3] \\
& + x[17] \times h[2] + x[18] \times h[1] = 9
\end{aligned}
$$



As we can see the outputs are the same.

4-

4-1:



4-2:

TI proof : $y[n] = x[n] + a x[n-n_0]$

$z[n] = x[n-n_1] \longrightarrow w[n] = z[n] + a z[n-n_0]$

$= x[n-n_1] + a x[n-n_1-n_0]$

از طرفی ، $y[n-n_1] = x[n-n_1] + a x[n-n_1-n_0]$

$\Rightarrow w[n] = y[n-n_1] \Rightarrow$ it's TI

linear proof : $y_1[n] = x_1[n] + a x_1[n-n_0]$

$y_2[n] = x_2[n] + a x_2[n-n_0]$

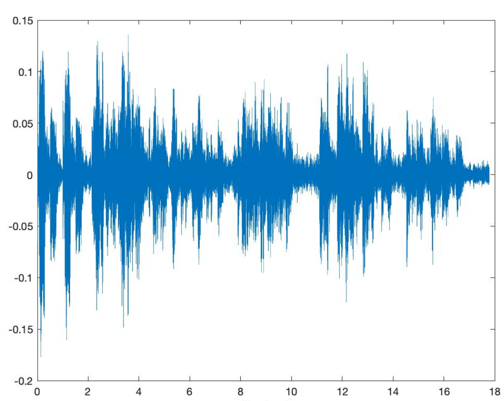
$z[n] = k_1 x_1[n] + k_2 x_2[n]$

$\rightarrow w[n] = z[n] + a z[n-n_0] = k_1 x_1[n] + k_2 x_2[n] + a k_1 x_1[n-n_0] + a k_2 x_2[n-n_0]$

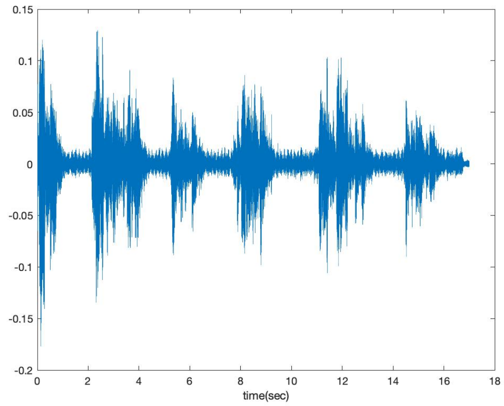
$= k_1 y_1[n] + k_2 y_2[n] \Rightarrow$ it's linear

$x[n] = \delta[n] \Longrightarrow y[n] = h[n] = \delta[n] + a\delta[n-n_0] \rightarrow$ پاسخ ضربه

4-3:



4-4



:4-5

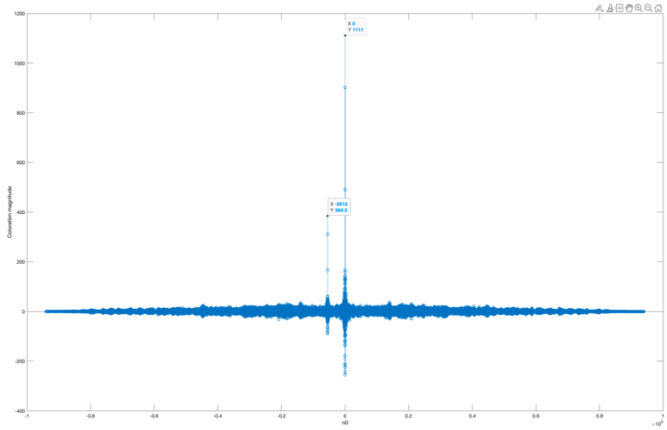
Correct Method:

Coherence is a measure indicating the similarity of a signal with itself or another signal. The method for obtaining this measure is as follows: We shift the first signal each time and multiply it with another signal (corresponding to it), and finally, we add all the values together. In fact, for each shift, we have a numerical value, and in the end, we will have a new signal. The maximum value of the new signal occurs when the first signal (which is being shifted) is exactly on top of itself (x[n]) or its shifted version (x[n-n_0]). The intuitive justification for this is that if we have a square with a fixed perimeter, its maximum area is when it is a square, meaning that its sides are equal. Therefore, when the first signal is on top of itself or its shifted version, its values reach power of 2 and are added together. The two points on the figure below show the difference between their first component, indicating the value of n_0, and their second .component, indicating the value of a, as mentioned above

$$n_0 = 0 - (-5512) = 5512$$

$$\sum_n x[n] * x[n] = 1111 \quad and \quad \sum_n x[n] * a \times x[n] = a \times \sum_n x[n] * x[n] = 384.5$$

$$\Rightarrow a = \frac{384.5}{1111} \approx 0.35$$



Incorrect Method:

As stated in the question: y[n] = x[n] + ax[n-n_0] So, if we subtract the output from the input, the remaining signal will be the shifted input signal multiplied by an unknown coefficient. The first moment that its value is non-zero will be n_0, and if we divide the value of the signal at that moment by the value of the input signal at the same moment, we can obtain a. Therefore, we have: y[n] - x[n] = ax[n-n_0] However, this method is incorrect because there is noise on the original sound that can originate from the software used to extract the output from the input. The reason for this noise is that the first element in the input and output must have the same value because the echo is generated after the sound itself. But as we can see, this is not the case, so we cannot rely on the first moment that has a non-zero value when we subtract the .input from the output. Hence, this method is not correct

```
x_test = 88511×1
      0.0078
           0
           0
     -0.0078
     -0.0078
     -0.0156
     -0.0234
     -0.0156
     -0.0312
     -0.0312
        ⋮

Fs_test = 11025
y_test = 94023×1
      0.0068
           0
           0
     -0.0068
     -0.0068
     -0.0136
     -0.0204
     -0.0136
     -0.0273
     -0.0273
        ⋮

fs_test = 11025
```