```
clc; clear all;
```

In the lecture we discussed this as an Moving Average Filter.

$$\longrightarrow H(z) = \frac{Y(z)}{X(z)} = \frac{1}{N}\sum_{k=0}^{N-1} z^{-k} = \frac{1}{N}\sum_{k=0}^{N-1}(1/z)^k$$

Due to the Geometrical row, we can write:

$$\sum_{k=0}^{N-1} a^k = \frac{1-a^N}{1-a}$$

$$\longrightarrow H(z) = \frac{1}{N}\sum_{k=0}^{N-1}(1/z)^k = \frac{1}{N}\frac{1-z^{-N}}{1-z^{-1}}$$

The System given in the Lab excersise is:

$$y(n) = y(n-1) + \frac{1}{N}(x(n) - x(n-1))$$

$$Y(z) = Y(z) * z^{-1} + (1 - z^{-1}) * X(z) * \frac{1}{N}$$

$$Y(z) - Y(z) * z^{-1} = +(1 - z^{-1}) * X(z) * \frac{1}{N}$$

By applying the condition $H(z) = \frac{Y(z)}{X(z)}$, we receive:

$$H(z) = \frac{1-z^{-N}}{1-z^{-1}} * \frac{1}{N}$$

The filter refers to an Moving Average Filter. The type of memory which is suitable for implementing the delay line is an FIFO.

To show the behaviour of the filter, two pairs of b and a coefficients are created. One pair is created similar to the lecture using $H(z) = \frac{1-z^{-N}}{1-z^{-1}} * \frac{1}{N}$:

```
fs = 8000;
Ts = 1/fs;

N     = 4;

num   = [1 zeros(1,N-1) -1];     % Coefficients of the numerator polynomial
(numerator)
denom = [1 -1]*N;
```

The others refer to the equation $\longrightarrow H(z) = \frac{Y(z)}{X(z)} = \frac{1}{N}\sum_{k=0}^{N-1} z^{-k} = \frac{1}{N}\sum_{k=0}^{N-1} (1/z)^k$

```
b = [0.25 0.25 0.25 0.25];
a = [1];
```

The Input Signal is generated like in the Lecture:

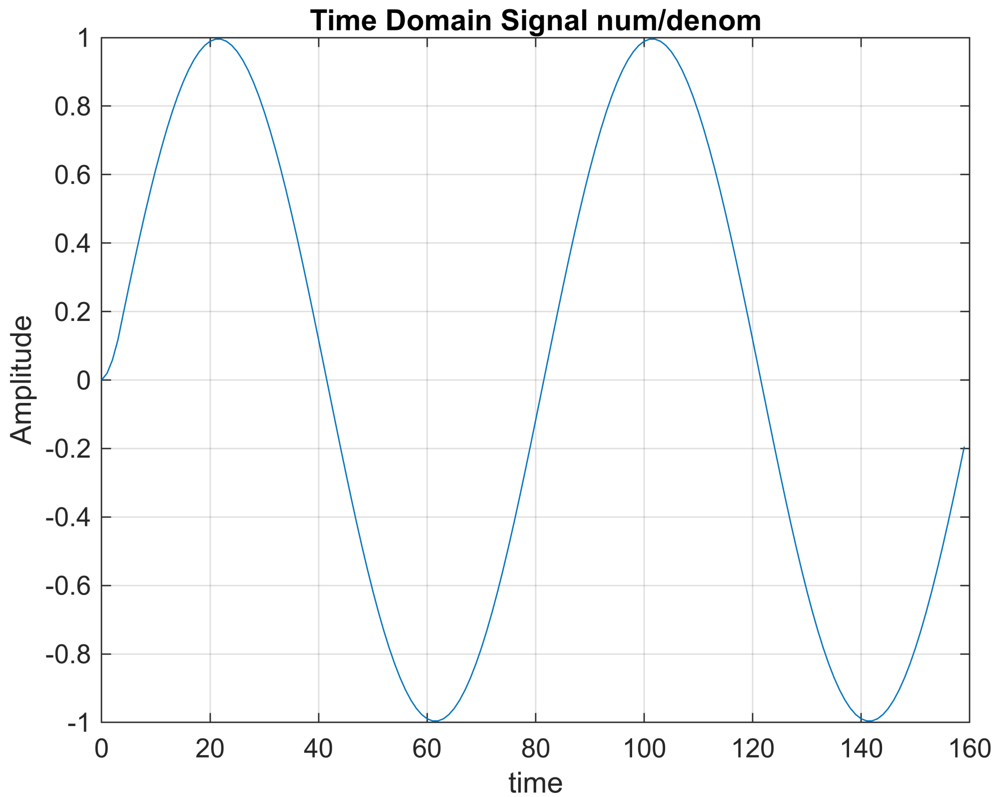
```
T = 1;
M = T/Ts;
n = 0:1:M-1;

f1 = 100;

P1 = 2*round(fs/f1);

x1 = sin(2*pi*f1*Ts*n);
```

After that the filter command is used to execute the filter operation.

```
y_num_denom = filter(num,denom,x1);
y_b_a = filter(b,a,x1);
```

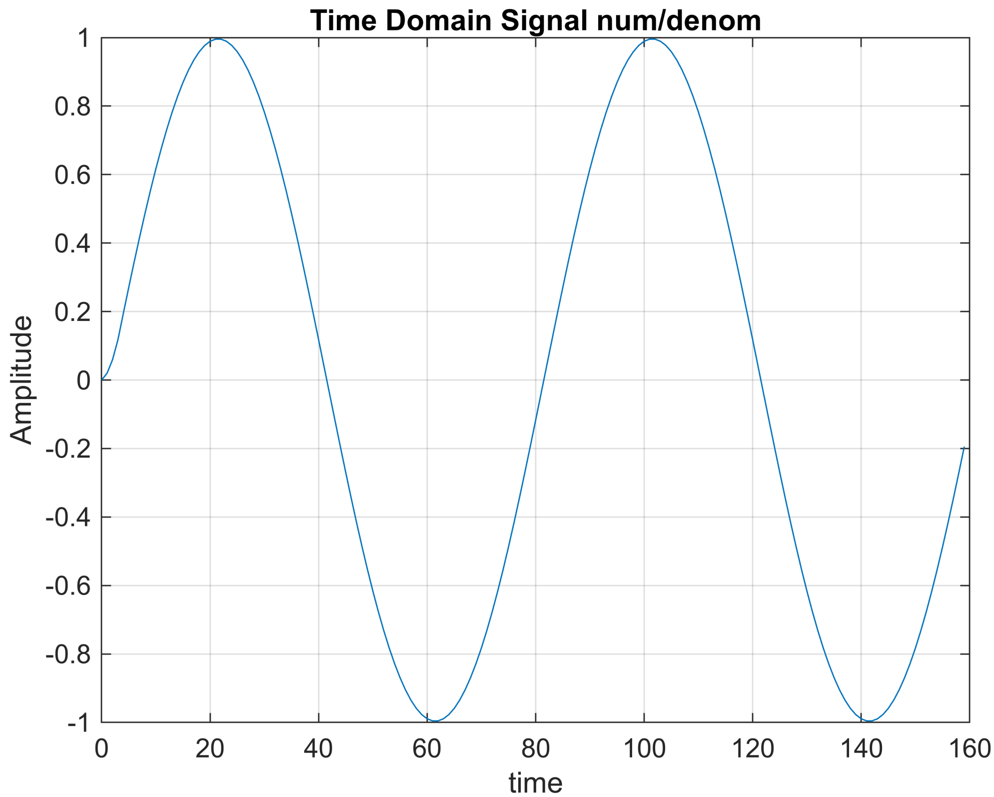
Plot $H(z) = \frac{1 - z^{-N}}{1 - z^{-1}} * \frac{1}{N}$

```
figure()
plot(n(1:P1),y_num_denom(1:P1));
title('Time Domain Signal num/denom');
xlabel('time');
ylabel('Amplitude');
grid on;
```



Plot $\longrightarrow H(z) = \frac{Y(z)}{X(z)} = \frac{1}{N}\sum_{k=0}^{N-1} z^{-k} = \frac{1}{N}\sum_{k=0}^{N-1}(1/z)^k$

```
figure()
plot(n(1:P1),y_b_a(1:P1));
title('Time Domain Signal num/denom');
xlabel('time');
ylabel('Amplitude');
grid on;
```


Time Domain Signal num/denom
Amplitude
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
20
40
60
80
100
120
140
160
time