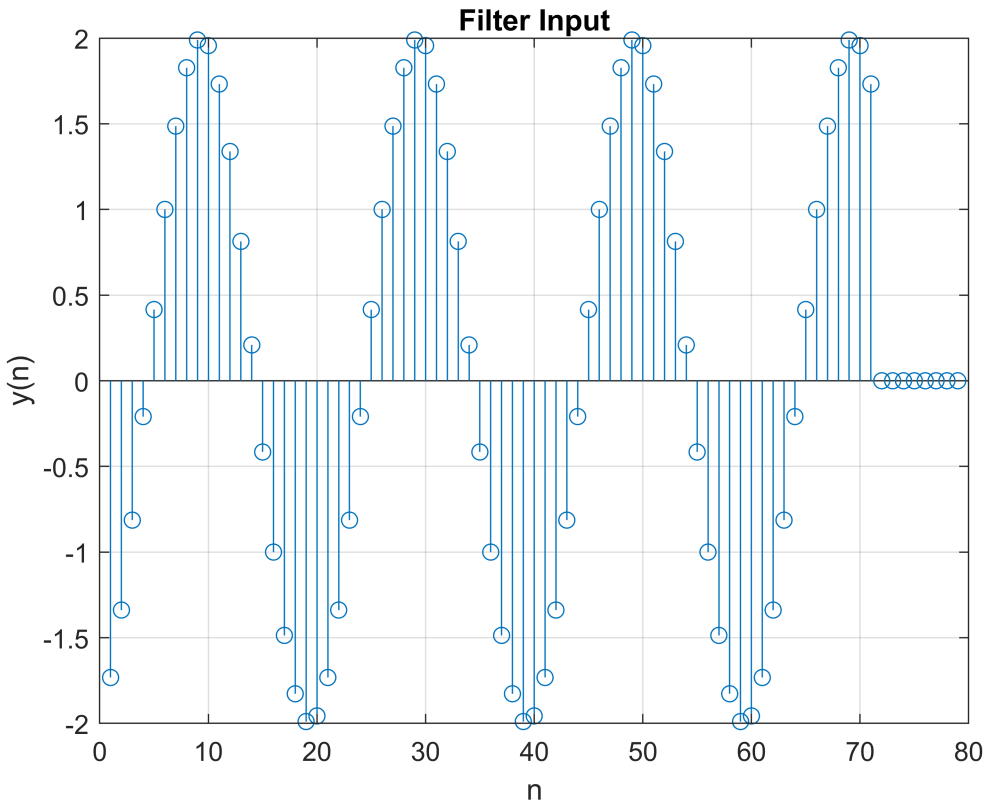
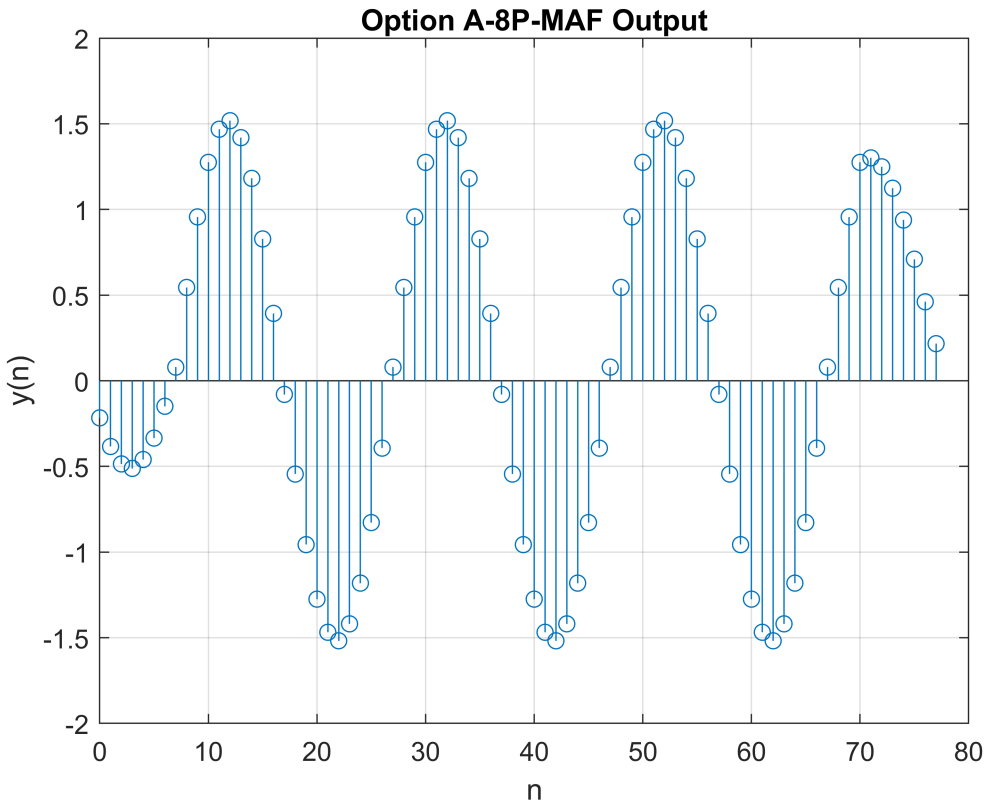
```
clc
clear all

%----------Question 1-------------%

% 8 point MA filter
h = (ones(1,8))./8;

% Overshooting of n to 70 samples instead of 40
n = 0:1:70;

% input
x = 2 * (sin((pi*n / 10) - (pi / 3)));

% Create a matrix and fill it with zeros
N1 = length(x);
N2 = length(h);
x = [x,zeros(1,N2)];
h = [h,zeros(1,N1)];

% Moving Average filter output
for i = 1: N1 + N2 - 1
    y(i) = 0;
    for j = 1:N1
        if((i-j+1)>0)
        y(i)=y(i)+(x(j)*h(i-j+1));
        end
    end
end

n = 0:1:length(y)-1;

% Plot of Filter input
stem(x);
grid;
xlabel('n');
ylabel('y(n)')
title('Filter Input')
```

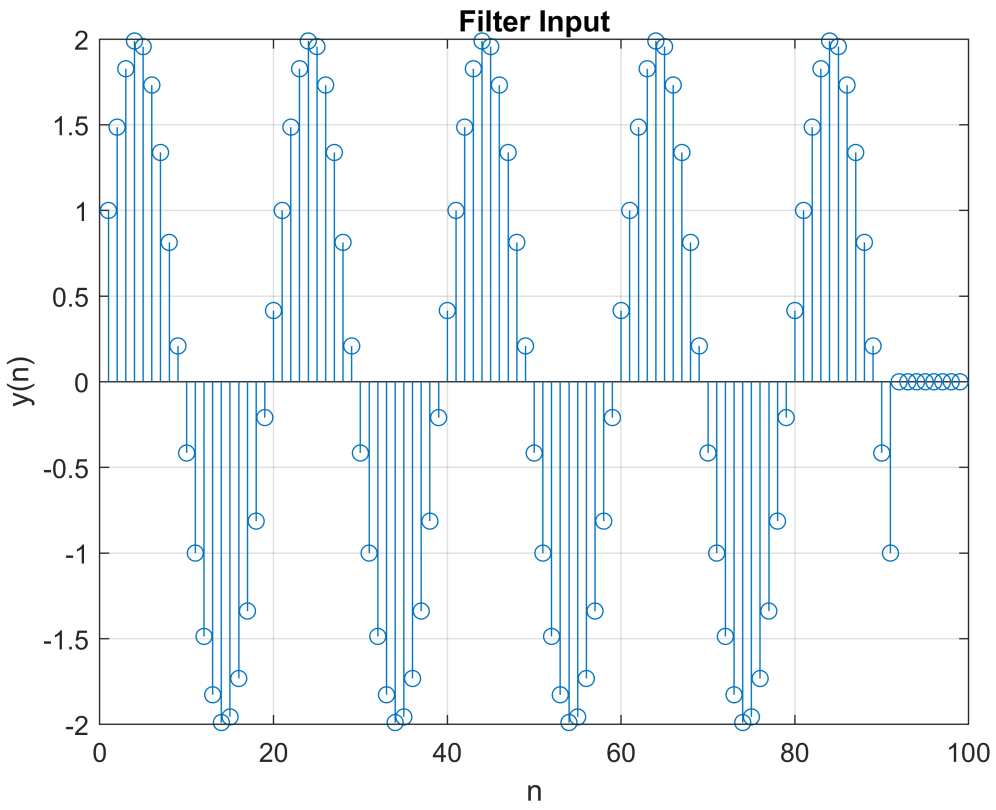



```
% Plot of Output Response
stem(n,y);
grid;
xlabel('n');
ylabel('y(n)')
title('Option A-8P-MAF Output')
```

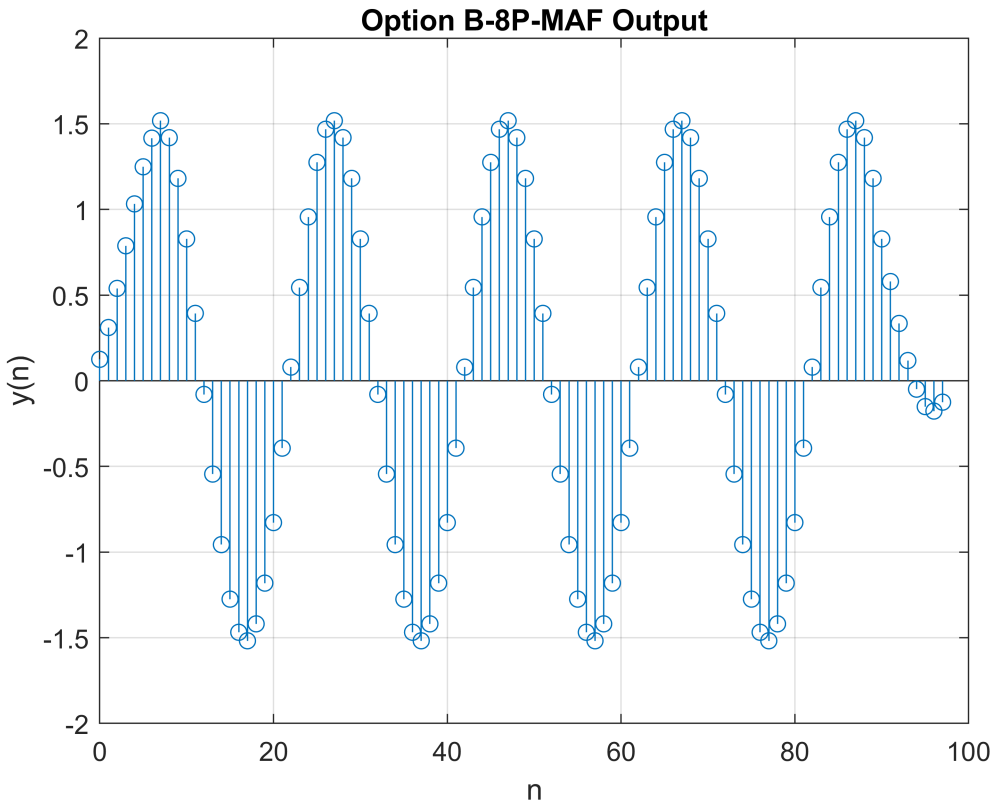



```
%-------------------OPTION B-----------------%
h = (ones(1,8))./8;

% Overshooting of n to 90 samples instead of 60
n = 0:1:90;

% input
x = 2 * (cos((pi*n / 10) - (pi / 3)));

% Create a matrix and fill it with zeros
N1 = length(x);
N2 = length(h);
x = [x,zeros(1,N2)];
h = [h,zeros(1,N1)];

% Moving Average filter output
for i = 1: N1 + N2 - 1
    y(i)=0;
    for j = 1:N1
        if((i-j+1)>0)
        y(i)=y(i)+(x(j)*h(i-j+1));
        end
    end
```

```
end

n=0:1:length(y)-1;

% Plot of Filter input
stem(x);
grid;
xlabel('n');
ylabel('y(n)')
title('Filter Input')
```

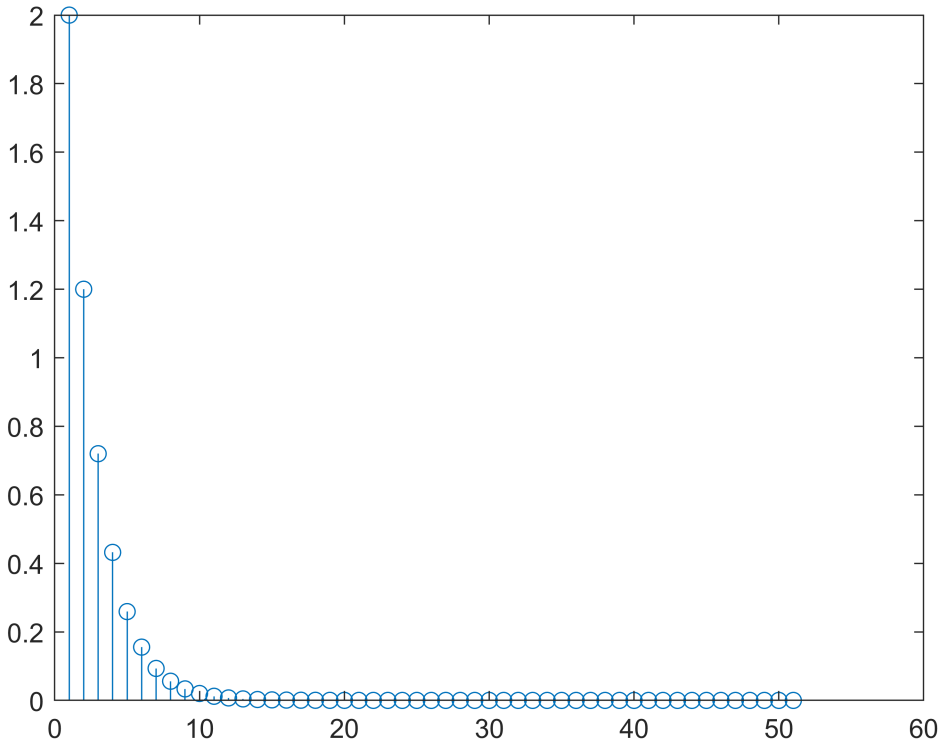



```
% Plot of Output Response
stem(n,y);
grid;
xlabel('n');
ylabel('y(n)')
title('Option B-8P-MAF Output')
```

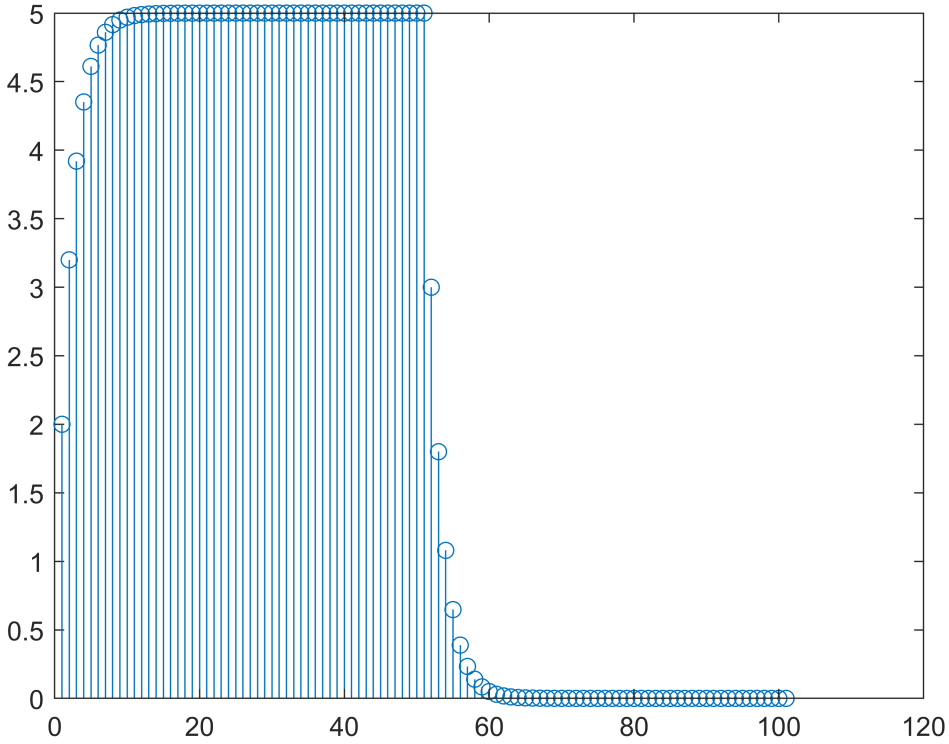



```
%----------Question 2-------------%

%-----------------OPTION A-----------------%
% Index
n = 0:50;
% Unit step signal
u = (n >= 0);
% h[n]
h = 2*0.6.^n.*u;

% A
x1 = u;
% Output to Response A
a_y = conv(h,x1);

% B
x2 = cos(n*pi/4).*u;
% Output to Response B
b_y = conv(h,x2);

% C
x3 = u + cos(n*pi/4).*u;
% Output To Response C
c_y = conv(h,x3);
```

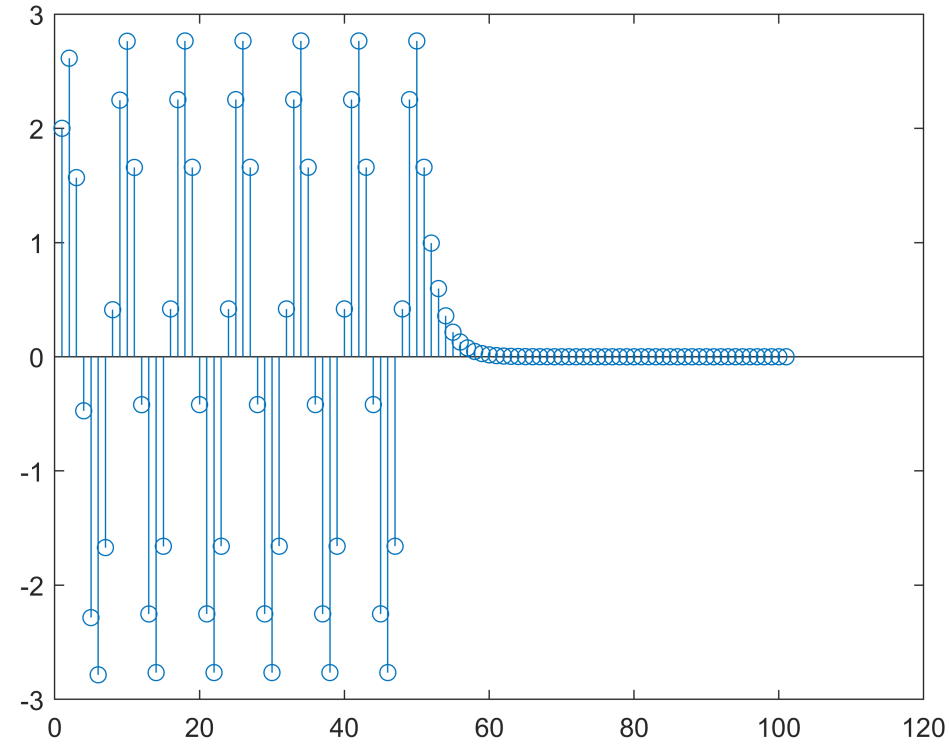
```
% Plot of h[n]
stem(h)
```



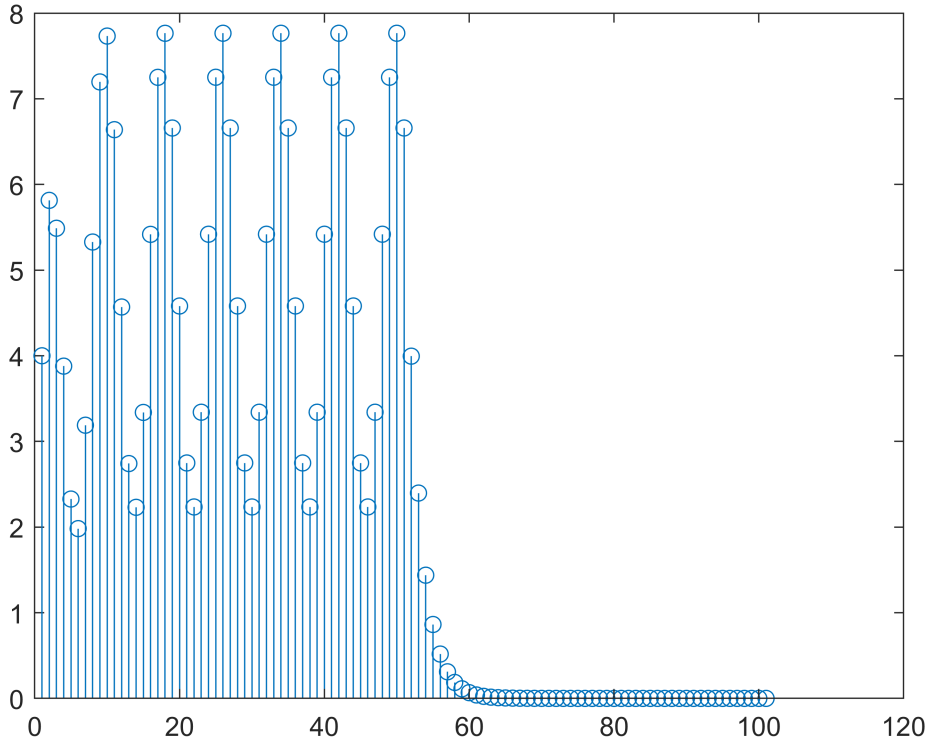

```
%------------Response Plot-------------%
% Plot of response A
stem(a_y)
```



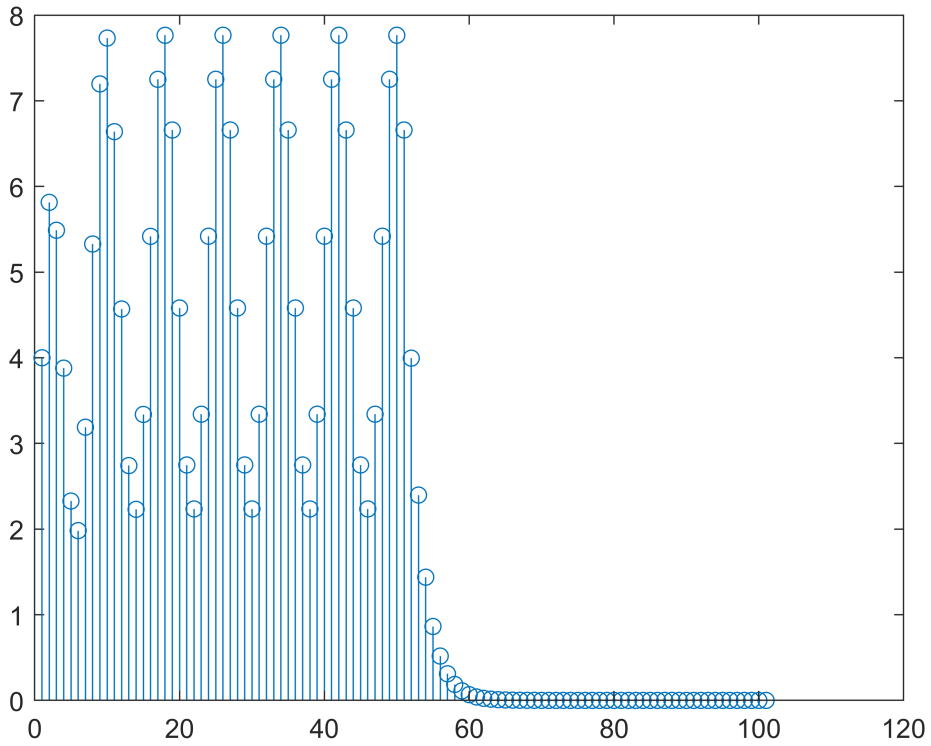

```
% Plot of response B
stem(b_y)
```



```
% Plot of response C
stem(c_y)
```




```
% Plot of response a+b=c satisfies linearity check
stem(a_y + b_y)
```

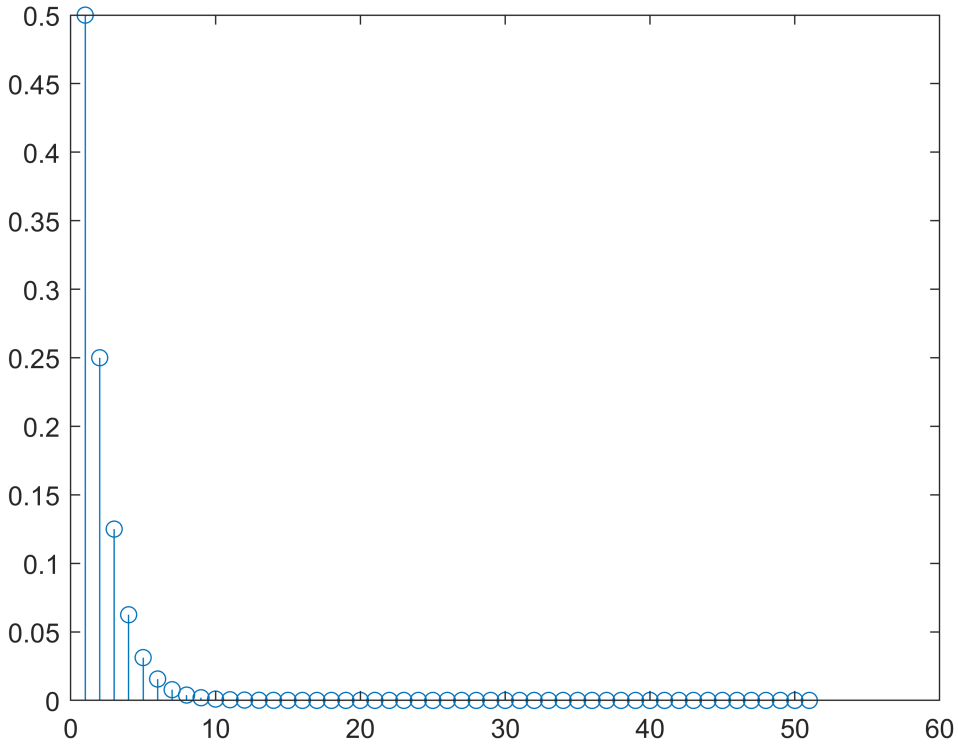



```
Result = 'From Observing the Plots you can realise that the response of c_y is the same as resp
disp(Result)
```

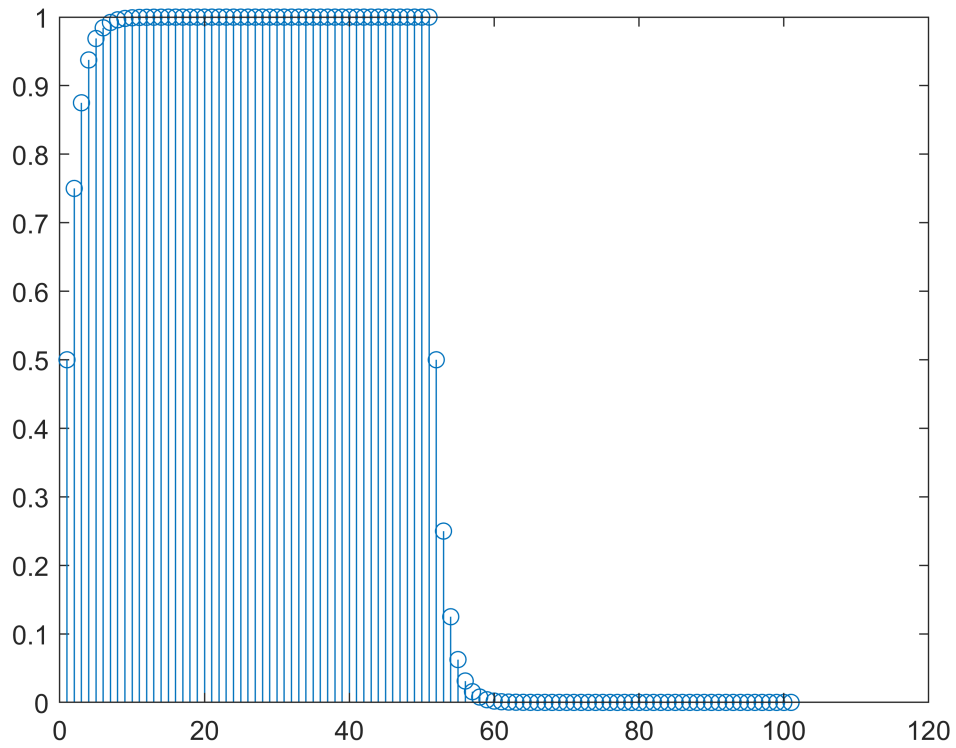
```
From Observing the Plots you can realise that the response of c_y is the same as response of  a_y + b_y hence syster
```

```
%-----------------OPTION B-----------------%
% Index
n = 0:50;
% Unit step signal
u = (n >= 0);
% h[n]
h = 0.5.^(n + 1).*u;

% A
x1 = u;
% Output to Response A
a_y = conv(h,x1);

% B
x2 = cos(n*pi/4).*u;
% Output to Response B
b_y = conv(h,x2);
```

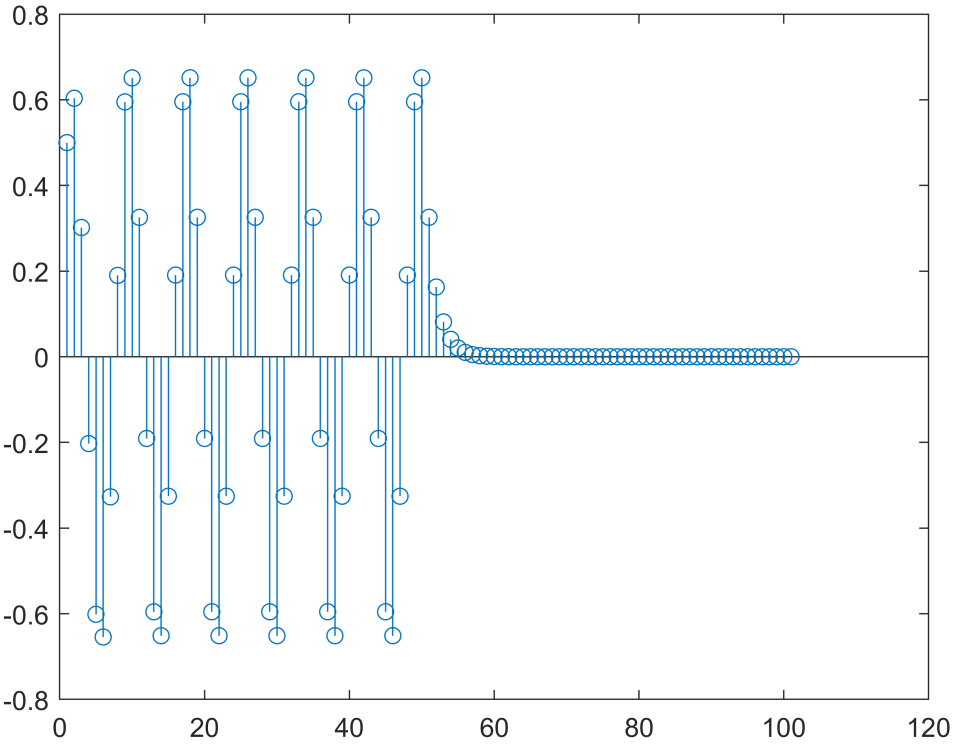
```
% C
x3 = u + cos(n*pi/4).*u;
% Output To Response C
c_y = conv(h,x3);

% Plot of h[n]
stem(h)
```



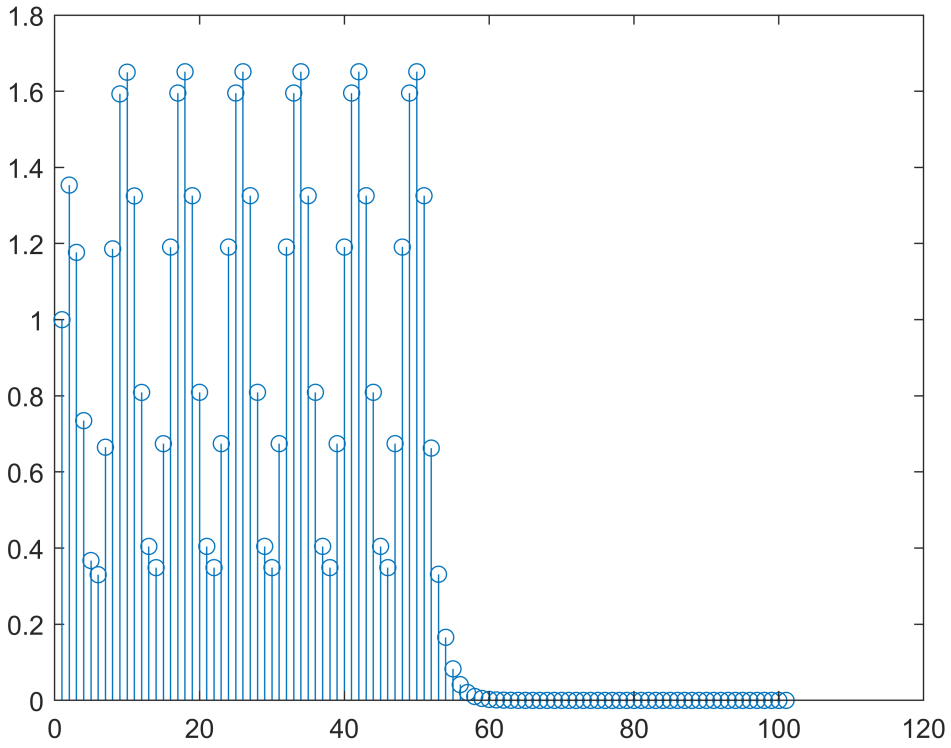

```
%------------Response Plot-------------%
% Plot of response A
stem(a_y)
```



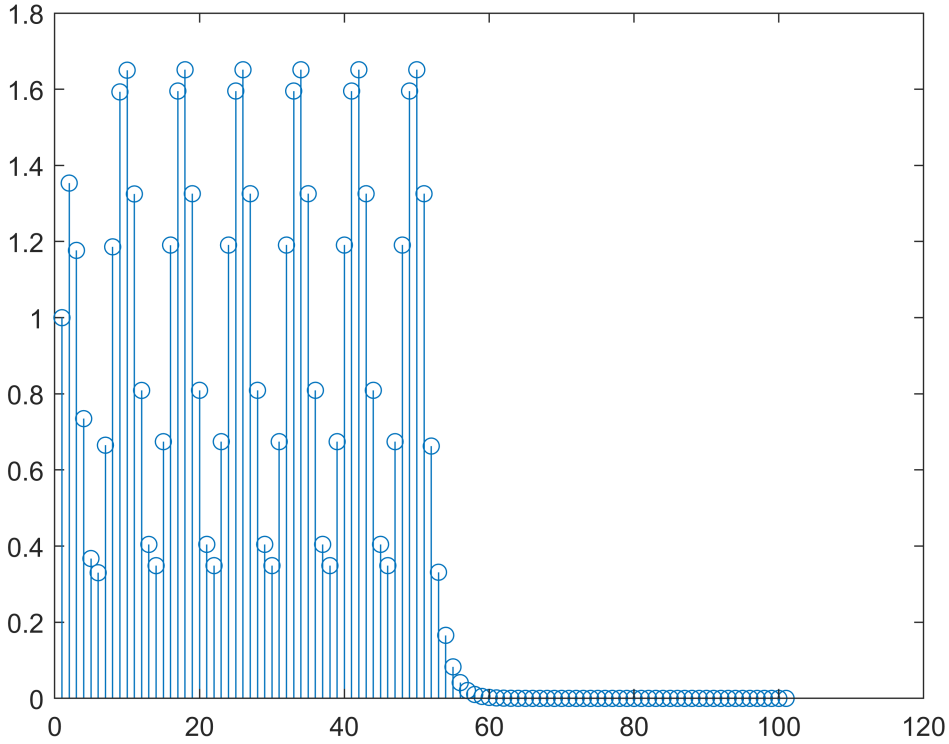

```
% Plot of response B
stem(b_y)
```



```
% Plot of response C
stem(c_y)
```




```
% Plot of response a+b=c satisfies linearity check
stem(a_y + b_y)
```




```
Result = 'From Observing the Plots you can realise that the response of c_y is the same as resp
disp(Result)
```

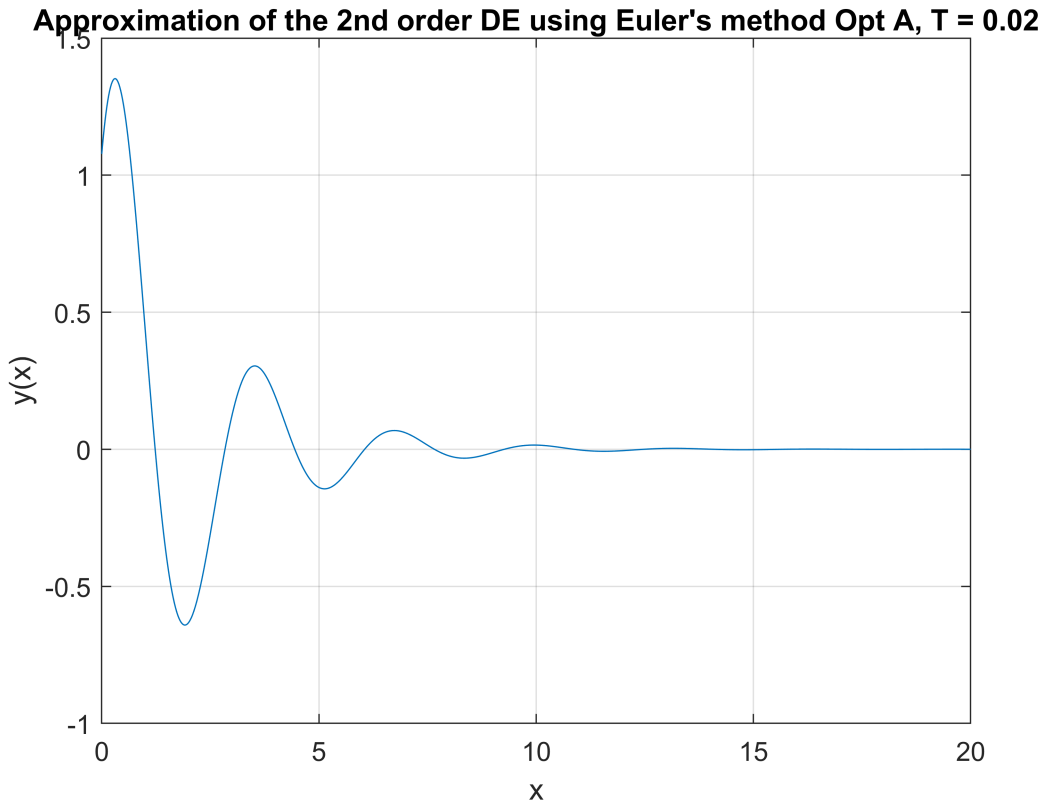
```
From Observing the Plots you can realise that the response of c_y is the same as response of  a_y + b_y hence syster
```

```
%----------Question 3-------------%

% A - initial conditions (y(0) = 1. y'(0) = 2
% Initialise sampling frequency and range of values
T = 0.02;
n = 0:T:20;

% Iniitalise required arguments for recur
a = [(-2 + T) (-T + 4*T.^2 + 1)];
b = [0 0 0];
x = ones(1, length(n));
x0 = [0 0];
y0 = [1 2.*T + 1];

% Get values and plot results
y = recur(a, b, n, x, x0, y0);
```

```
x = 1×1003
     0     0     1     1     1     1     1     1     1     1     1     1     1 ···
```

```
a1 = 1×2
    0.9816   -1.9800
b1 = 1×3
     0     0     0
y = 1×1001
    1.0776    1.1128    1.1455    1.1759    1.2037    1.2292    1.2522    1.2728 ···
```

```
figure
plot(n, y)
grid
xlabel("x")
ylabel("y(x)")
title("Approximation of the 2nd order DE using Euler's method Opt A, T = 0.02")
```

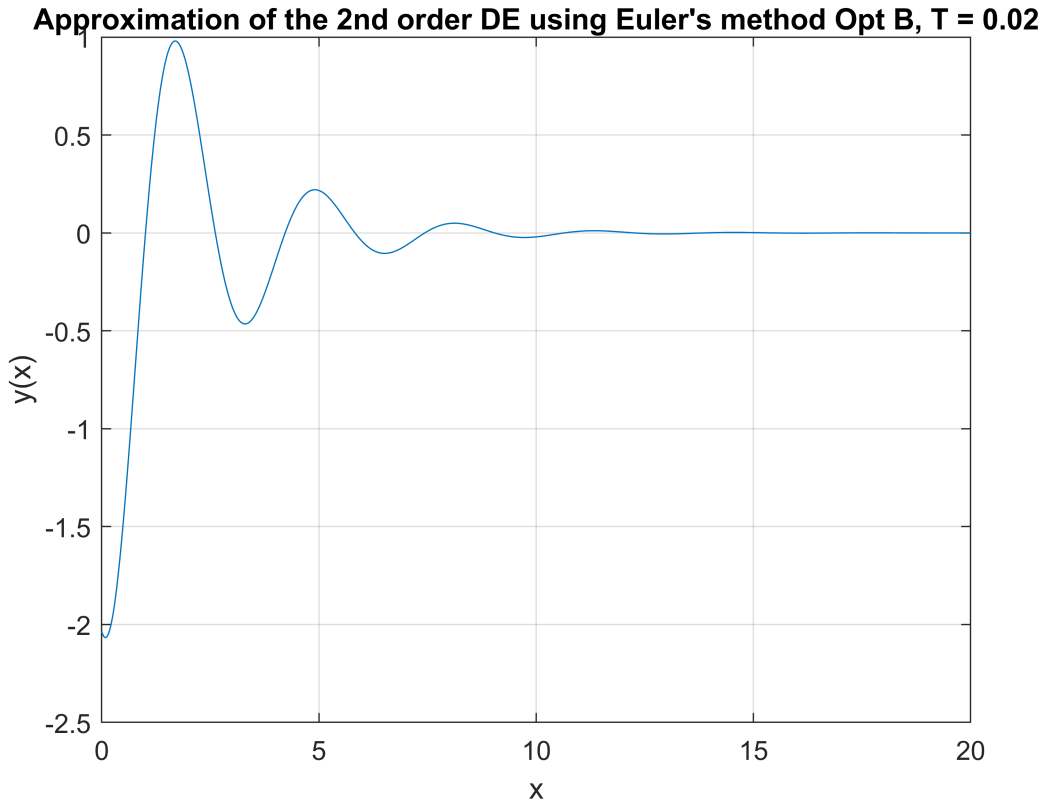



```
% B - only initial conditions change. but both options still have the same
% y(0) = -2, y'(0) = -1

% Initialise sampling frequency and range of values
T = 0.02;
n = 0:T:20;

% Initialise required arguments for recur
a = [(-2 + T) (-T + 4*T.^2 + 1)];
b = [0 0 0];
x = ones(1, length(n));
x0 = [0 0];
```

```
y0 = [-2 -T-2];

% Get values and plot
y = recur(a, b, n, x, x0, y0);
```

```
x = 1×1003
     0     0     1     1     1     1     1     1     1     1     1     1     1 ···
a1 = 1×2
    0.9816   -1.9800
b1 = 1×3
     0     0     0
y = 1×1001
   -2.0364   -2.0492   -2.0586   -2.0644   -2.0669   -2.0660   -2.0618   -2.0544 ···
```

```
figure
plot(n, y)
xlabel("x")
ylabel("y(x)")
title("Approximation of the 2nd order DE using Euler's method Opt B, T = 0.02")
grid
```




```
%----------Question 4-------------%

%---------Part A---------%
clear;

plotTo = 20;
```

```
syms t tau;

h = exp(-t)*sin(t);
IsA = (1-cos(t))*(heaviside(t)-heaviside(t-plotTo));
IsB = (1+sin(t))*(heaviside(t)-heaviside(t-plotTo));

% the calculation for the terms inside each integral is performed here
toIntegrateA = subs(h,tau)*subs(IsA,t-tau);
toIntegrateB = subs(h,tau)*subs(IsB,t-tau);

% the integrations for each convolution are calculated and printed to display
IoA = int(toIntegrateA,tau,0,t)
```

```
IoA =
```

$$\text{heaviside}(t-20)\left(\frac{\cos(t)}{5}+\sigma_1-\frac{e^{20-t}\,(2\cos(t-40)+\sin(t-40)+5\sin(t))}{10}+\frac{e^{20-t}\,(\cos(t-20)+\sin(t-\right.$$

where

$$\sigma_1=\frac{2\sin(t)}{5}$$

```
IoB = int(toIntegrateB,tau,0,t)
```

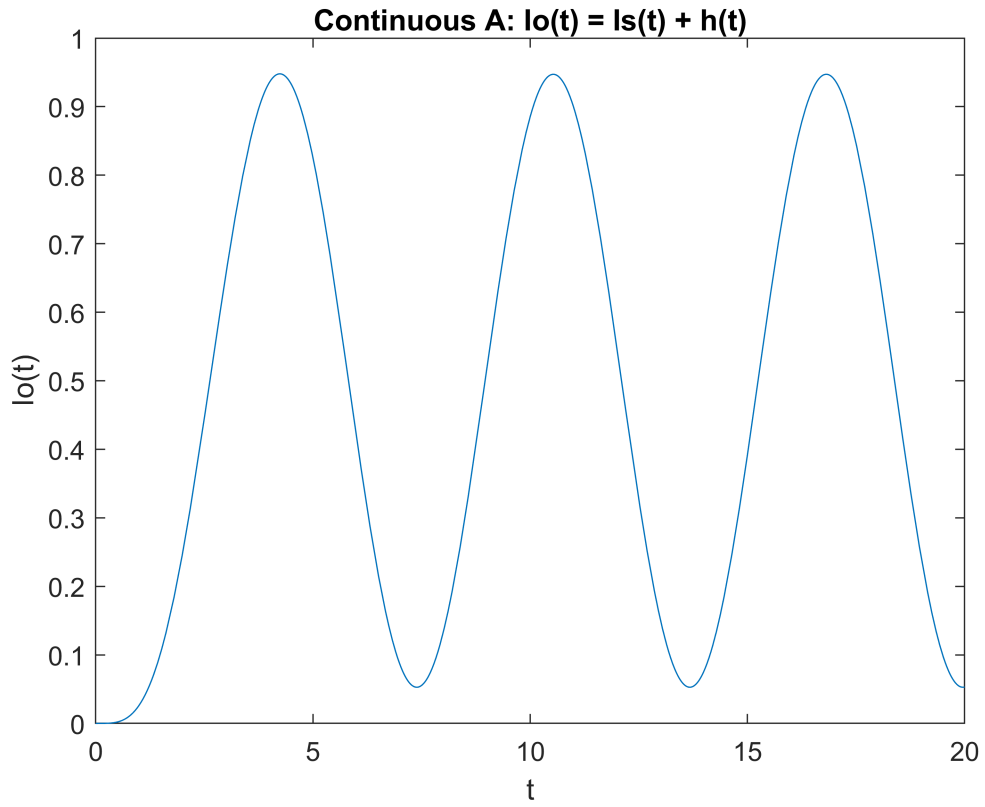
```
IoB =
```

$$-\text{heaviside}(t)\left(\sigma_1-\frac{\sin(t)}{5}+\frac{e^{-t}\cos(t)}{10}+\frac{3\,e^{-t}\sin(t)}{10}-\frac{1}{2}\right)-\text{heaviside}(t-20)\left(\frac{\sin(t)}{5}-\sigma_1+\frac{e^{20-t}\,(2\sin(t\right.$$

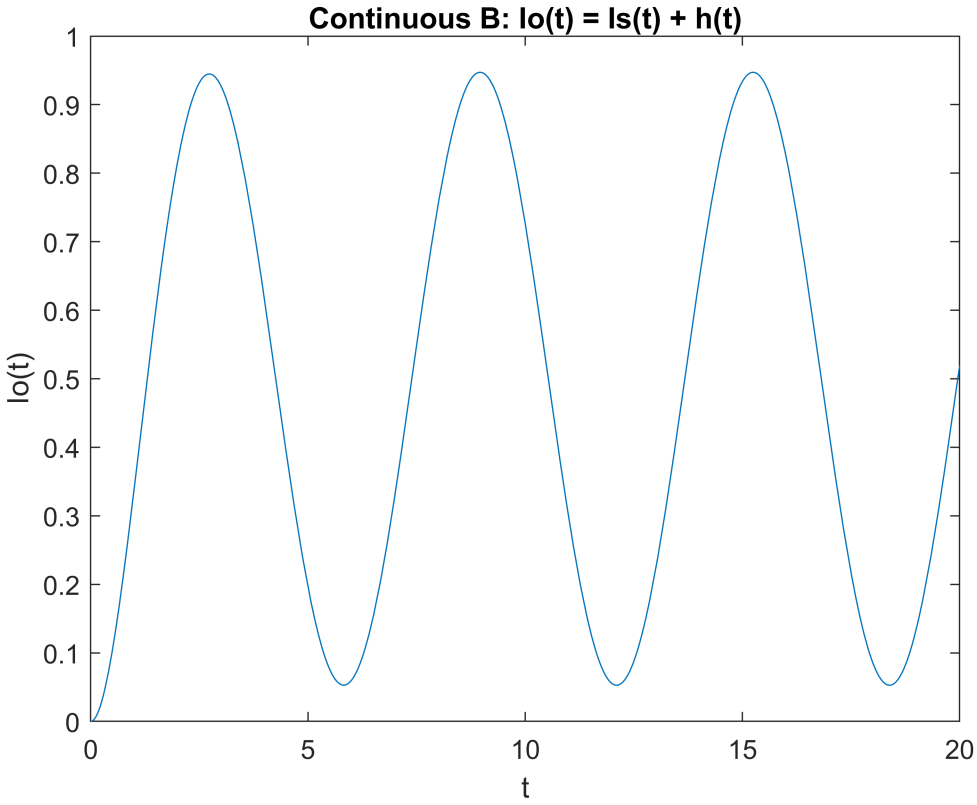
where

$$\sigma_1=\frac{2\cos(t)}{5}$$

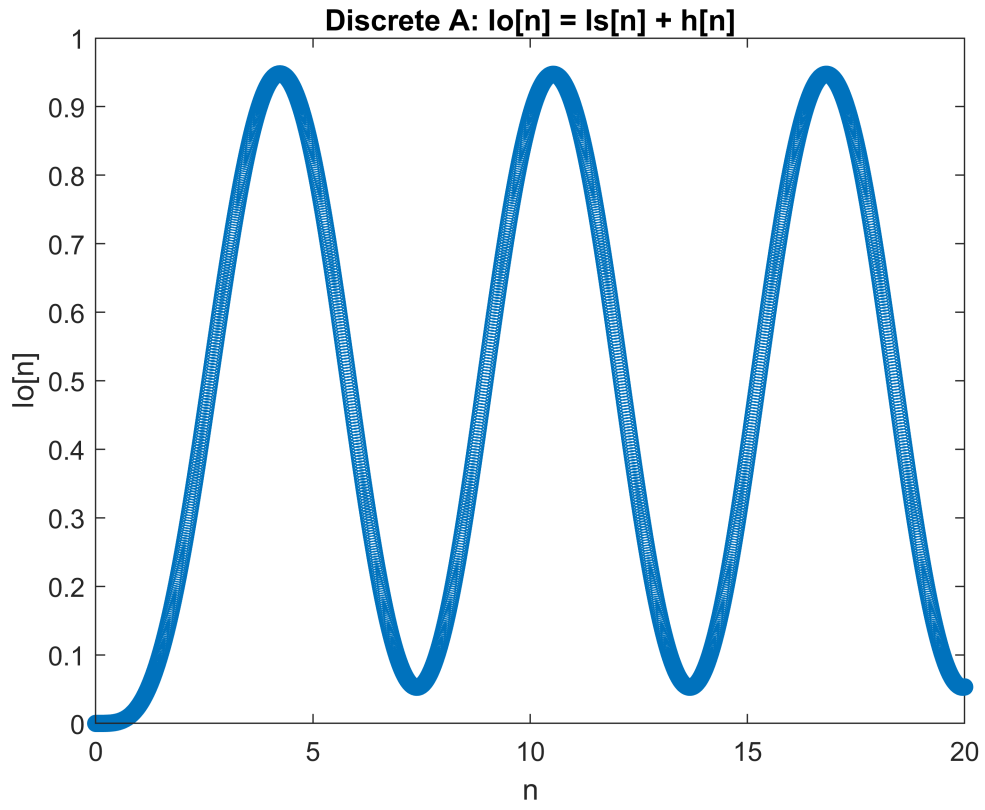
```
% plot for option A
fplot(t, IoA, [0 plotTo]);
title('Continuous A: Io(t) = Is(t) + h(t)');
ylabel('Io(t)');
xlabel('t')
ylim([0 1])
```



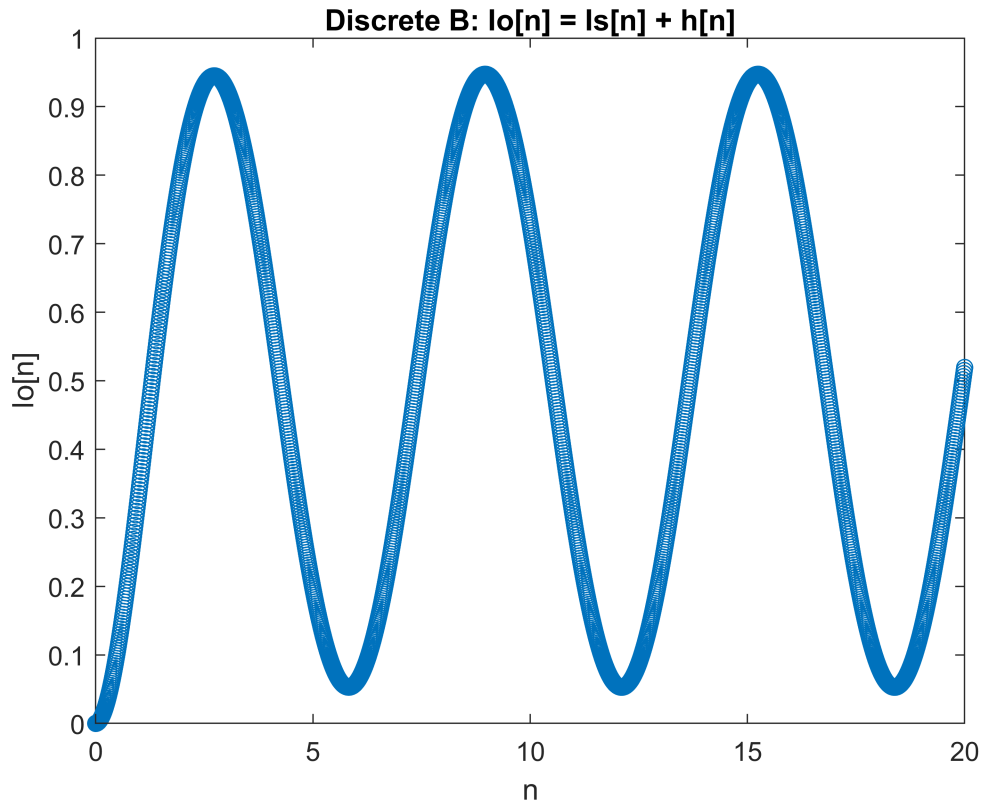

```
% plot for option B
fplot(t, IoB, [0 plotTo]);
title('Continuous B: Io(t) = Is(t) + h(t)');
ylabel('Io(t)');
xlabel('t')
ylim([0 1])
```




```
%-----------Part B----------%

plotTo = 20; % value the convolution will occur to
T = 0.01; % sample rate
n = 0:T:plotTo; % discrete values to convolute over

% definitions for h and the Is values of part A and B
h = exp(-n).*sin(n);
IsA = (1-cos(n));
IsB = (1+sin(n));

% performing convolutions and scaling for parts A and B
IoA = conv(h, IsA).*T;
IoB = conv(h, IsB).*T;

% chopping of convolutions to correct dimension
IoA = IoA(1:length(n));
IoB = IoB(1:length(n));

% displaying the graphs for the discrete results
stem(n, IoA, 'linestyle','none');
ylim([0 1]);
title('Discrete A: Io[n] = Is[n] + h[n]');
ylabel('Io[n]');
xlabel('n');
```




```
stem(n, IoB, 'linestyle','none');
ylim([0 1]);
title('Discrete B: Io[n] = Is[n] + h[n]');
ylabel('Io[n]');
xlabel('n');
```




```
%---------Part C---------%

%Looking at the plots for both the continuous and discrete-time methods reveals that these plot
%each other when viewed at this scale. This is because the small sample rate of 0.01 for the di
%forms an excellent approximation of the solution for the continuous version.
```