2.2. Generate a MATLAB plot of the output response $y[n]$ for $5 \le n \le 40$ of the 5-point EWMA filter with $b = 0.7$ when the input $x[n]$ is

(a) $x[n] = 1, 0 \le n \le 40$

- Also, plot $x[n]$ for $0 \le n \le 40$ (no stem labels) and plot $y[n]$ for $0 \le n \le 5$ (w/ stems labeled). Assume $x[n]$ is zero for all other indices.

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% Problem 2.2a (p2_2a.m)
% Compute and plot the output y[n] of a 5 point exponentially-weighted
% moving average (EWMA) filter, with b=0.7, for n = 5 to 40
% when the input is x[n] = 1 for n= 0 to 40.
% Also, plot x[n] for n= 0 to 40.
clear; clc; close all
N = 5;    % Number of points in EWMA filter
b = 0.7; a = (1-b)/(1-b^N);  % find EWMA constants
i = 0:1:N-1; w = a*b.^i;     % weighted EWMA filter coefficients
% Note that vector w(i) is indexed from 1 to 6 in MATLAB,
% i.e., w(1)=w[i=0], w(2)=w[i=1], ... w(5)=w[i=4]
x = ones(1,41); % define the input signal
% Note that vector x(i) is indexed from 1 to 41 in
% MATLAB, i.e., x(1)=x[n=0], x(2)=x[n=1], ... x(41)=x[n=40]
%
for n=6:41, % time index loop (w/ offset equiv. to n=5 to 40)
    y(n) = w(1)*x(n)+w(2)*x(n-1)+w(3)*x(n-2)+...
        w(4)*x(n-3)+w(5)*x(n-4);
end
nx = 0:1:40;  % index vector for stem plot of x[n] for n = 0 to 40
stem(nx,x,'r.','linewidth',2,'markersize',20), grid
axis([0 40 0 1.2]);
ylabel('{\itx}[{\itn}]','fontsize',16,'fontname','times')
xlabel('{\itn}','fontsize',16,'fontname','times')
title('2.2a: N=5 EWMA filter w/ {\itx}[{\itn}]=1 for 0 \leq n \leq 40',...
    'fontsize',14,'fontname','times')
%
nplot = 5:1:40;  % index vector for stem plot of y[n] for n = 5 to 40
figure, stem(nplot,y(nplot+1),'r.','linewidth',2,'markersize',20),
grid, axis([5 40 0 1.2]);
ylabel('{\ity}[{\itn}]','fontsize',16,'fontname','times')
xlabel('{\itn}','fontsize',16,'fontname','times')
title('2.2a: N=5 EWMA filter w/ {\itx}[{\itn}]=1 for 0 \leq n \leq 40',...
    'fontsize',14,'fontname','times')
%
% Examine EWMA filter behavior as it 'charges' up n = 0 to 4
y(1)= w(1)*x(1); % y[0]
y(2)=w(1)*x(2)+w(2)*x(1); % y[1]
y(3)=w(1)*x(3)+w(2)*x(2)+w(3)*x(1); % y[2]
y(4)=w(1)*x(4)+w(2)*x(3)+w(3)*x(2)+w(4)*x(1); % y[3]
y(5)=w(1)*x(5)+w(2)*x(4)+w(3)*x(3)+w(4)*x(2)+w(5)*x(1); % y[4]
nplot2 = 0:1:5;  % index vector for second stem plot
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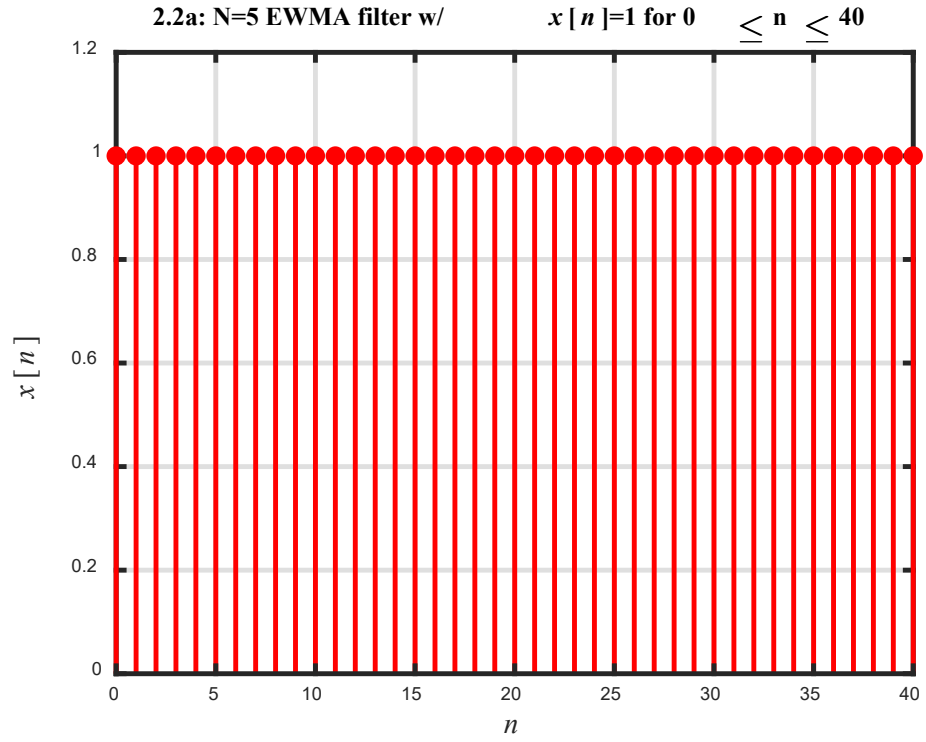
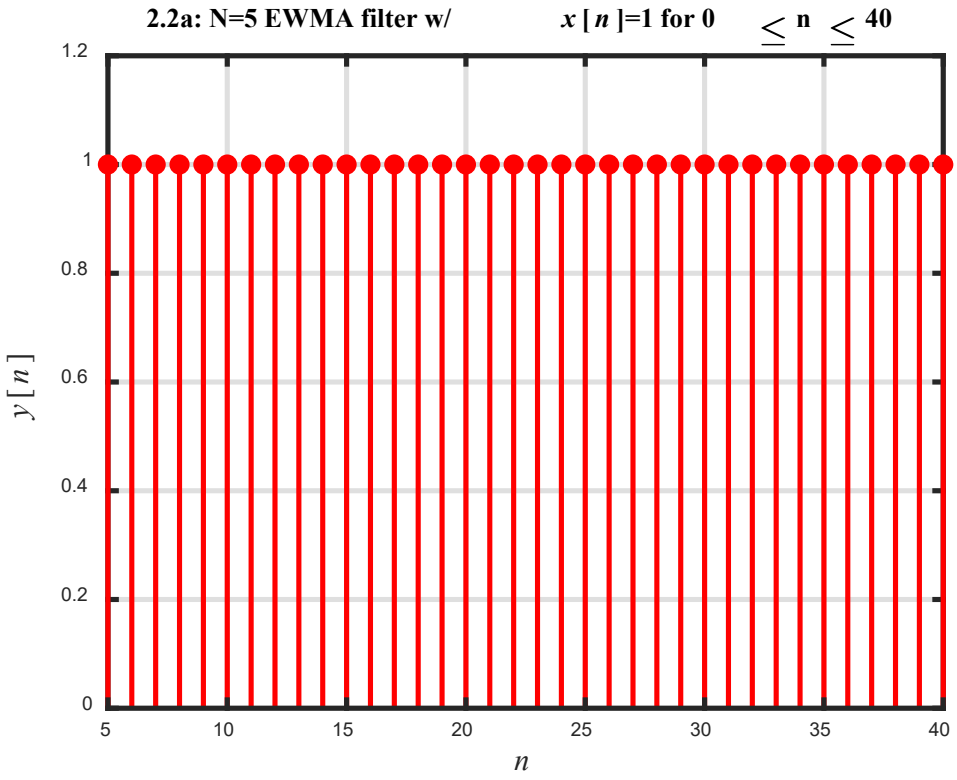
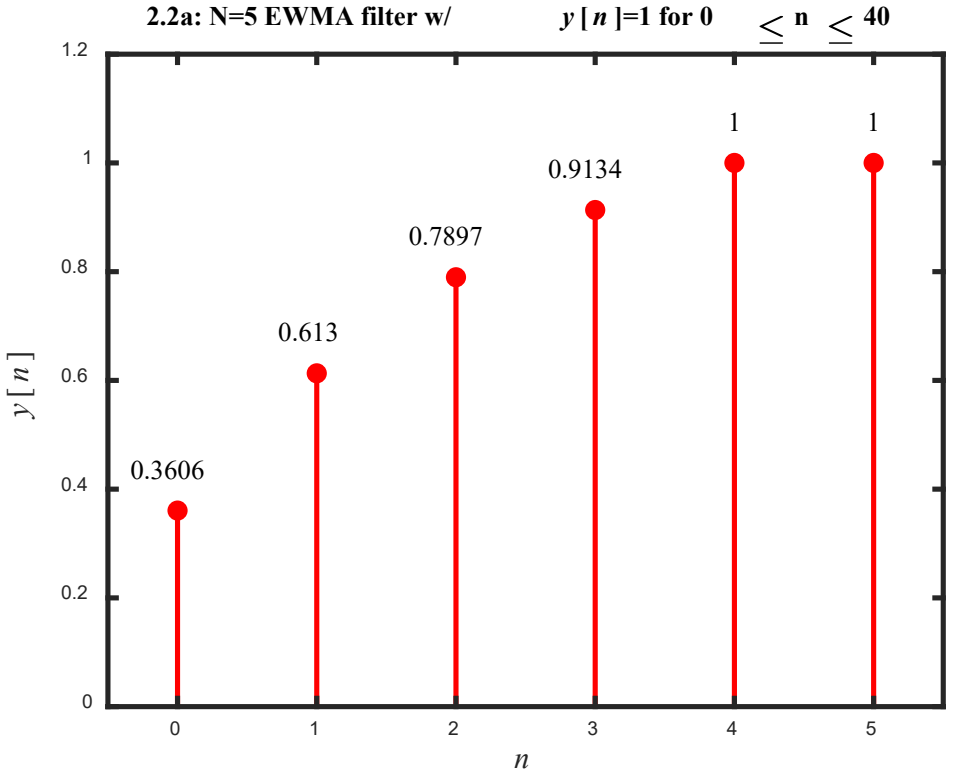
```
figure, % plot y[n] for n = 0 to 5
stem(nplot2,y(nplot2+1),'r.','linewidth',2,'markersize',20),
axis([-0.5 5.5 0 1.2]);
ylabel('{\ity}[{\itn}]','fontsize',16,'fontname','times')
xlabel('{\itn}','fontsize',16,'fontname','times')
title('2.2a: N=5 EWMA filter w/ {\ity}[{\itn}]=1 for 0 \leq n \leq 40',...
    'fontsize',14,'fontname','times')
% Label these stems with the value of y[]
for n=1:6,  % can go to length(i)
    text(nplot2(n),y(n)+0.02,[' ' num2str(y(n),4)],...
        'HorizontalAlignment','center','VerticalAlignment','bottom')
end
set(findobj('type','text'),'fontname','times','fontsize',14)
set(findobj('type','line'),'linewidth',1.5,'markersize',20)
set(findobj('type','axes'),'linewidth',2)
```







1) For $N = 5$, the EWMA filter has $b = 0.7$ and $a = 0.3606$. This yields weights: $w_0 = ab^0 = 0.3606$, $w_1 = ab^1 = 0.2524$, $w_2 = ab^2 = 0.1767$, $w_3 = ab^3 = 0.1237$, & $w_4 = ab^4 = 0.0866$.
2) For this input, $y[0] = w_0 = 0.3606$, $y[1] = w_0 + w_1 = 0.613$, $y[2] = w_0 + w_1 + w_2 = 0.7897$, $y[3] = w_0 + w_1 + w_2 + w_3 = 0.9134$, and $y[4] = w_0 + w_1 + w_2 + w_3 + w_4 = 1$ (as expected).