```matlab
% Moving Average Example
clc, clf;
 clear;        % clear all
% Create a sine wave with noise
f=100;            % 100 Hertz  T=0.01 seconds
fs=5000;          % Create 5000 samples/sec
t=0:1/fs:.03;     % Time scale - fs*0.03= 150 so 151 points
 x=sin(2*pi*f*t);           %original signal
 v=.1, r=v*randn(1,length(t));    %noise
 Xw=x+r;                   %signal plus noise (filter input)
%  3 point moving average h=3
 for n=3:length(Xw),
   y(n)=sum(Xw(n-2:n))/3;     %y[n] is the filtered signal, n=3,4,5,
 end
% MODIFY TO PLOT y VERSUS t, ADD XLABEL, YLABEL, AND TITLE
figure(1),plot(t,y,'r',t,Xw,'b'), grid;
gtext('Red is smoothed by 3-point MA')
 % PUT ON A LEGEND for your plot
save('xdata.mat','t','Xw')
clear all
load('xdata.mat')
a=1
b=[1/3 1/3 1/3]
y2=filter(b,a,Xw);
figure(2)
plot(t,y2,'r',t,Xw,'b'),grid, gtext('Red is smoothed by filter 3-point MA')
```
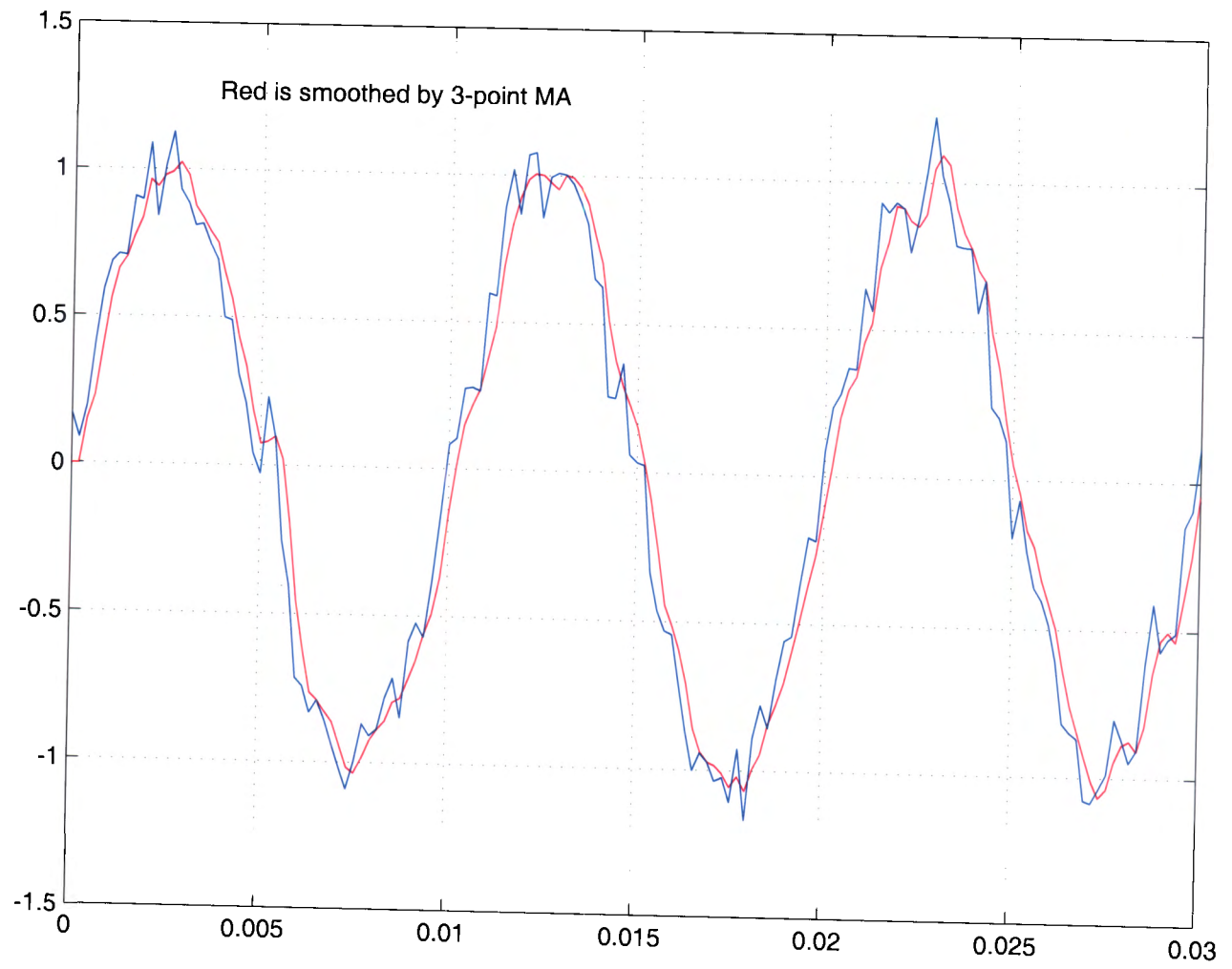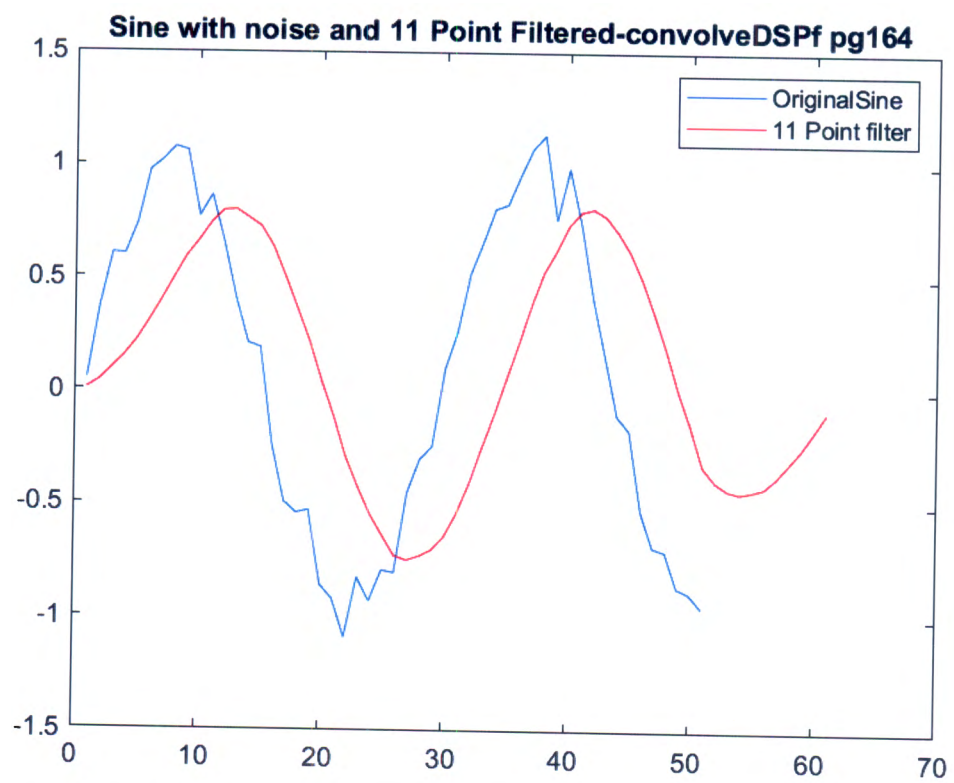
SUM

FILTER

Red is smoothed by 3-point MA

```matlab
% DSP F Page 164   convolveDSPF_164
xn= sin(0.07*pi*(0:50))+0.1*randn(1,length(xn)); % 1x51
hn=ones(11,1)/11          % 11x1
yn=conv(hn,xn);           % 51 +11 -1 = 61
figure(1)

plot(xn),grid
hold on
plot(yn,'r')
title('Sine with noise and 11 Point Filtered-convolveDSPf pg164')
legend('OriginalSine','11 Point filter')
hold off
```
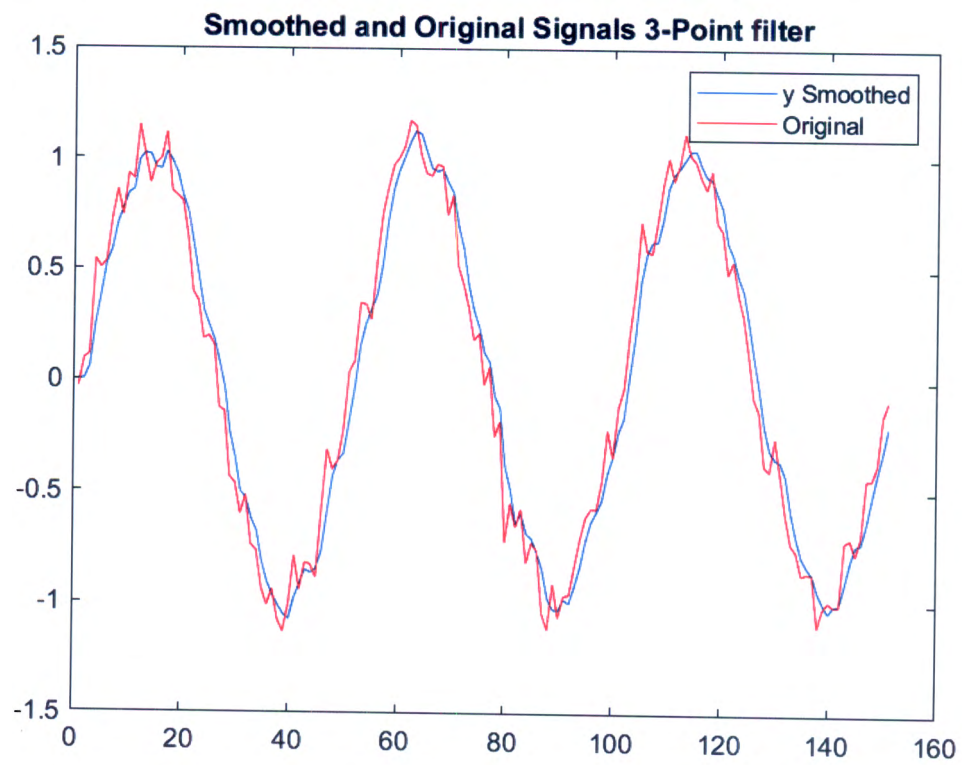
**Sine with noise and 11 Point Filtered-convolveDSPf pg164**

Legend:
- OriginalSine
- 11 Point filter

```matlab
% Moving Average Example Sum and Convolve
clc, clf;
 clear;              % clear all

 v=.01
 f=100;
 fs=5000;
 t=0:1/fs:.03
x=sin(2*pi*f*t);                      %original signal
  r=sqrt(v)*randn(1,length(t));       %noise
Xw=x+r;                               %signal plus noise (filter input)
                                      %   h=3 Length Xw = 151
 for n=3:length(Xw),
    y(n)=sum(Xw(n-2:n))/3;            %y[n] is the filtered signal
 end
% Convolution Solution
h=(1/3)*[1 1 1]
y1= conv(Xw,h);    % y1 = 151+3 -1 = 153
% MODIFY TO PLOT y VERSUS t, ADD XLABEL, YLABEL, AND TITLE
figure(1)
plot(y);           % Filtered
hold;
plot(Xw,'r');      % Original with Noise
title('Smoothed and Original Signals 3-Point filter')
legend('y Smoothed','Original')
% PUT ON A LEGEND
figure(2)
plot(y1)
hold;
plot(Xw,'r')
title('Smoothed and Original Signals with Convolution 3-Point filter')
legend('y Smoothed','Original')
```
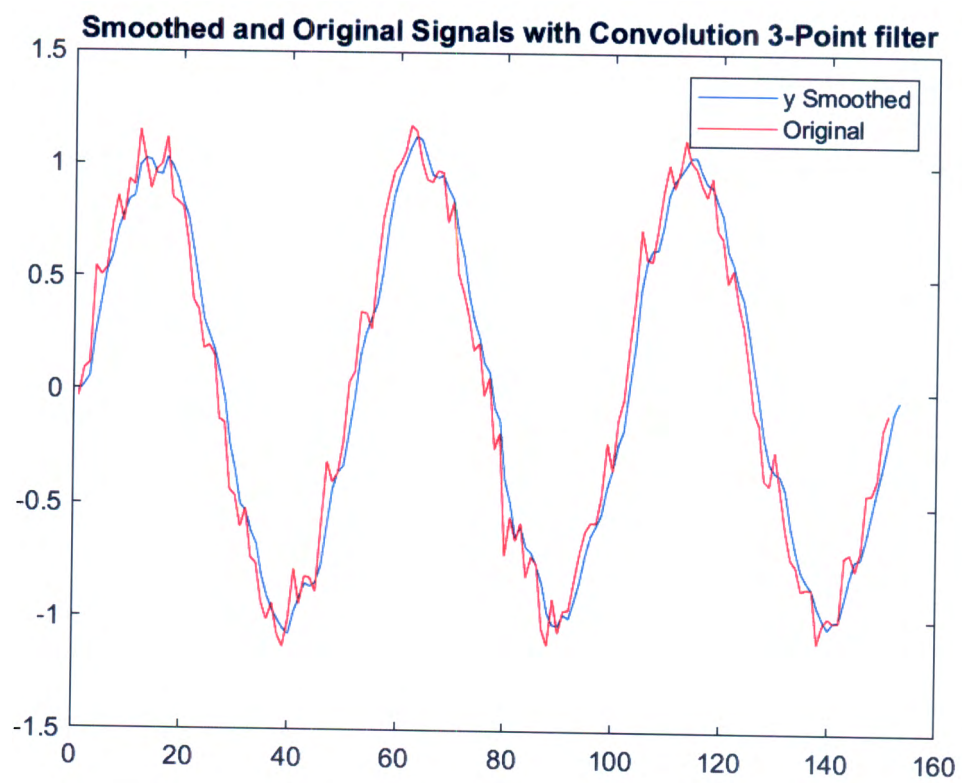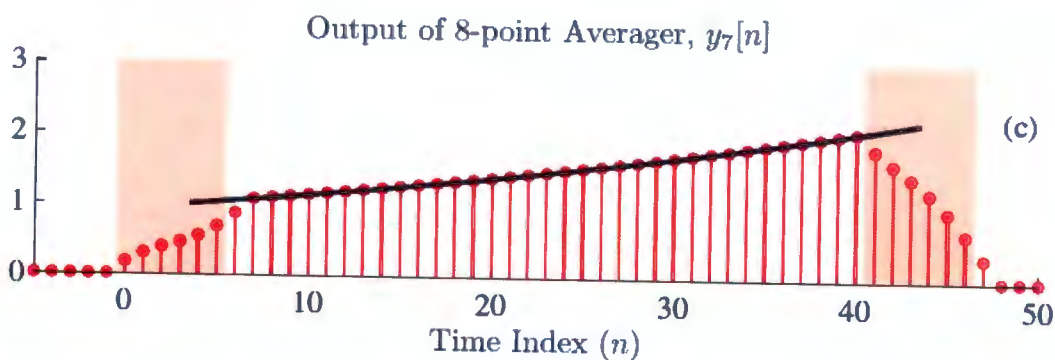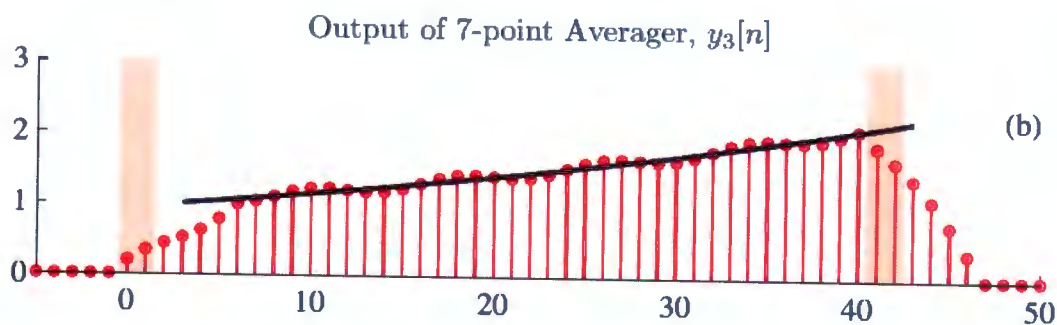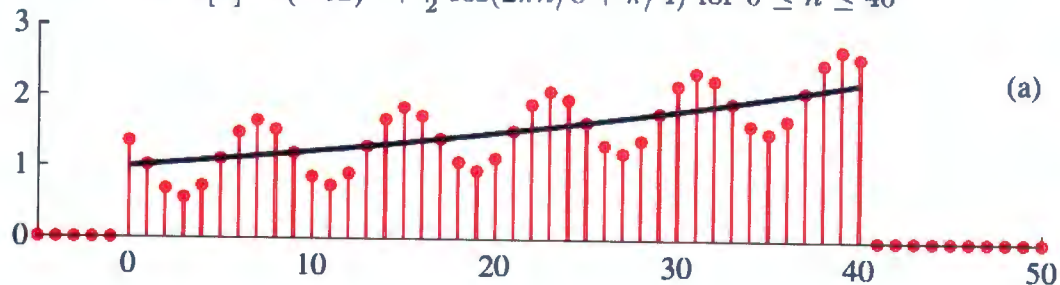
*CONVOLVE*

Smoothed and Original Signals 3-Point filter

Smoothed and Original Signals with Convolution 3-Point filter

PAGE 158

$$x[n] = (1.02)^n + \tfrac{1}{2}\cos(2\pi n/8 + \pi/4) \text{ for } 0 \le n \le 40$$



(a)

Output of 7-point Averager, $y_3[n]$



(b)

Output of 8-point Averager, $y_7[n]$



(c)

Time Index $(n)$

Part (c) of the above figure verifies that the sinusoid is completely removed for $7 \le n \le 40$. The reason is that the period of the sinusoid is 8 and therefore the filter always averages over one period no matter the value of $n$. Note in (b) that the 7-point averager leaves a small sinusoidal component.