```
%%  Section 1 Basic Math
% Angles degrees to/from radians    R = deg2rad(D)  D = rad2deg(R)
fprintf('Basic Math Convert angles\n')
format short
D1ang=90;   % 90 degrees
D1rad = deg2rad(D1ang);  D1radpi=D1rad/pi;    % 1.5708 rad  or 0.5*pi
% R1= deg2rad(126.87);  % 2.2143 rad
formatSpec = 'Angle D1ang is %4.3f degrees or % 4.3f radians\n';
fprintf(formatSpec,D1ang,D1rad)
fprintf('  Hit a key\n');pause;
R1rad= 2.4747;
D1deg=rad2deg(R1rad);   % 1.417e+02  141.79*pi/180 rad
formatSpec = 'Angle R1rad is %4.3f radians or % 4.3f degrees\n';
fprintf(formatSpec,R1rad,D1deg)
fprintf('  Hit a key');pause;
% D2=rad2deg(2*pi)     % 360 deg   360*pi/180 rad
R2=deg2rad(135);      % 2.35 rad
R2pi = 2.356194490192345/pi;   % .75*pi  3/4*pi  135 deg
R3rad=deg2rad(60);     % 1.407 rad
R3radpi=R3rad/pi;      % .3333..*pi  pi/3
R3deg=rad2deg(pi/3);  % 60 deg
R4=deg2rad(45);        % 0.7854 rad  45 deg
R4pi = R4/pi;         % .25*pi  pi/4

%% 2. Complex numbers
fprintf('Complex Numbers')
% abs   Absolute value of a real or complex number  (Magnitude)
% angle Argument or phase angle (polar angle) of a complex number
% exp  For complex Z=X+i*Y, exp(Z) = exp(X)*(COS(Y)+i*SIN(Y)).
% real  Real part ofcomplex number
% imag  Imaginary part of complex number
% conj  Complex conjugate    conj(X) = REAL(X) - i*IMAG(X) for complex X
% [theta,rho]=cart2pol(x,y)   x and y could be vectors
% [x,y] = pol2cart(theta,rho)
% feather Plot Vectors by r,theta
%% Complex Example  0+1*j
fprintf(' 0+j*1 to Polar\n')
[thetaex,rhoex]=cart2pol(0,1);     % 1,angle= 1.5708 rad  or 1/pi/2
thetaexpi=thetaex/pi;              % angle .5*pi rad
formatSpec = 'Magnitude rhoex is %4.3f and angle is %4.3f rad\n';
fprintf(formatSpec,rhoex,thetaex)
fprintf('  Hit a key- See Compass Plot');pause;
[x,y]= pol2cart(thetaex,rhoex);     % 6.123233995736766e-17,1 Close to [0,1]
figure(1)
compass(x,y)
title(' Vector 0+j*1')
fprintf('  Hit a key');pause;
% Complex Problems
z1=-1+j*0; z1exp=exp(x);z1arg=angle(z1)    % 1 3.141592653589793  (pi)
%  exp(j*pi/4)
z2exp =exp(j*pi/4)  % 0.707106781186548 + 0.707106781186548i
```

```
z2abs = abs(z2exp); z2arg=angle(z2exp); z2argpi=z2arg/pi  % 1/0.7854  pi/4
[z2x,z2y]= pol2cart(z2arg,z2abs);z2=z2x+j*z2y  % Cartesian 0.707+j+*0.707
z3= cos(pi/3)+j*sin(pi/3)
z3abs = abs(z3); z3arg=angle(z3)    % 0.5000 + 0.866i or 1/1.0471975511
z3argpi=z3arg/pi    % 0.3333   pi/3
%  Plots of z
xvec = [real(z1) real(z2) real(z3)], yvec= [imag(z1) imag(z2) imag(z3)]
figure(2)
compass(xvec,yvec)
title('Vectors z1,z2,z3')
% 3. Magnitude
z3=-4+j*3;z3mag=sqrt(z3*conj(z3))  % sqrt(x^2+y^2) = 5
z3mag2=sqrt(real(z3)^2+imag(z3)^2) % Magnitude r= 5
%% 4.Addition of /cartesian/polar Forms Convert to Cartesian,
% Add as x+j*y, Convert Back
% Addition Example 1 add cartesian after conversion
[x1,y1]= pol2cart(angle(exp(j*pi/3)),abs(exp(j*pi/3))) % (.5,0.866)
[x2,y2]= pol2cart(angle(exp(j*pi)),abs(exp(j*pi)))  % (-1,0)
zaddex = x1+x2 +j*(y1+y2)  % [-0.500000000000000,0.866025403784439]
% Convert to exponential
[thetazaddex,rhozaddex]=cart2pol(real(zaddex),imag(zaddex))
%   rhozaddex =1; thetazaddex = 2.094395102393196 rad
%  z3exadd_exp = 1*exp(j*2.0943) %  1* exp(j*2*pi/3)
% 4 Problems
[x4_1,y4_1]= pol2cart(angle(sqrt(2)*exp(j*pi/4)),abs(sqrt(2)*exp(j*pi/3))) %
[x4_12,y4_12]= pol2cart(angle(sqrt(2)*exp(-j*pi/4)),abs(sqrt(2)*exp(-j*pi/4)))
zadd4_1 = x4_1+x4_12 +j*(y4_1+y4_12)  % 2
% Convert to exponential
[thetaz4_1,rhoz4_1]=cart2pol(real(zadd4_1),imag(zadd4_1)) %  2/0 rad or deg
% 4_2
[x4_2,y4_2]= pol2cart(angle(7*exp(j*4*pi/7)),abs(7*exp(j*4*pi/7))) %
[x4_22,y4_22]= pol2cart(angle(5*exp(-j*5*pi/11)),abs(5*exp(-j*5*pi/11)))
% xz1= -1.5576+j*6.8245    z42 = .7116 +j*(-4.9491)
zadd4_2 = x4_2+x4_22 +j*(y4_2+y4_22)  % -0.84607 + 1.87538i
% Convert to exponential
[thetaz4_2,rhoz4_2]=cart2pol(real(zadd4_2),imag(zadd4_2)) %
%      2.057405/1.9946   2.05*exp(j*1.9946)
%% Rotating Vector
clf
%A=1.0;f0=1;phi=-pi/4;
A=1.0;f0=1;phi=0;  % Amplitude 1; f0=1 Hz, T0=1 second period
N=8; % 8 plots
Ts = 1/8  %  Sample 8 samples per second (Ts = 0.125 seconds)
figure(3)
for n= 0:N-1
    subplot(4,2,n+1)  % 4 plots in 2 columns
    t=0:1/200:1;   % Time axis 0 to 1 second (dt = 1/200 sec)
    plot(cos(2*pi*t),sin(2*pi*t),'k:')  % Plot the circle  (k us black)
    hold on
    z=A*exp(j*(2*pi*f0*n*Ts+phi));      % The vector at each time step nTs
    plot([0,real(z)],[0,imag(z)],'Linewidth',1)
```

```
    title(sprintf('Time = %1.4f s',n*Ts));
    axis(1.1*[-A A -A A]); axis equal;  % Define the axes range + 10%
    plot(real(z),imag(z),'r.','MarkerSize',18)
    hold off
end



%% Moving Average
% Moving Average Example
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
 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(4)
 plot(y);
 hold;
 plot(Xw,'r');
title('Smoothed and Original Signals with 3-Point filter')
 legend('y Smoothed','Original')
 % PUT ON A LEGEND
 figure(5)
 plot(y1)
 hold;
 plot(Xw,'r')
```

FIGURE 1

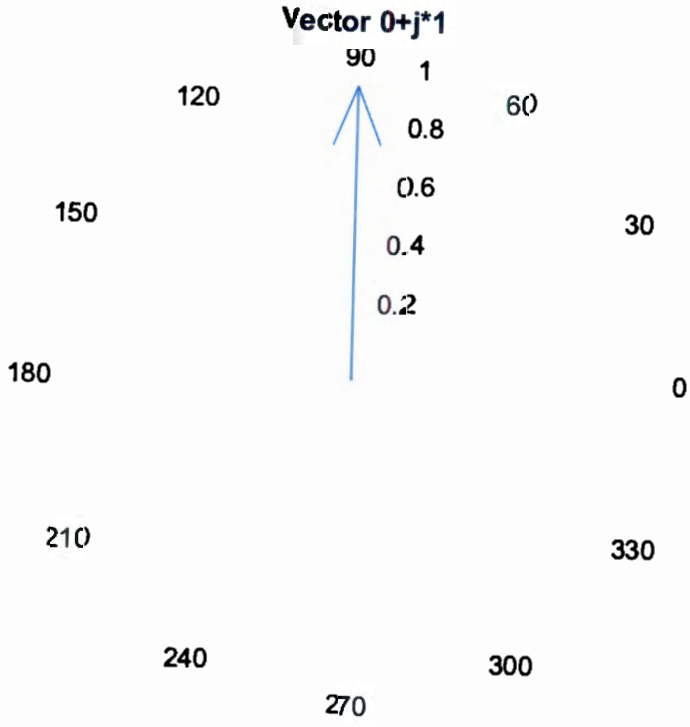


Figure 2

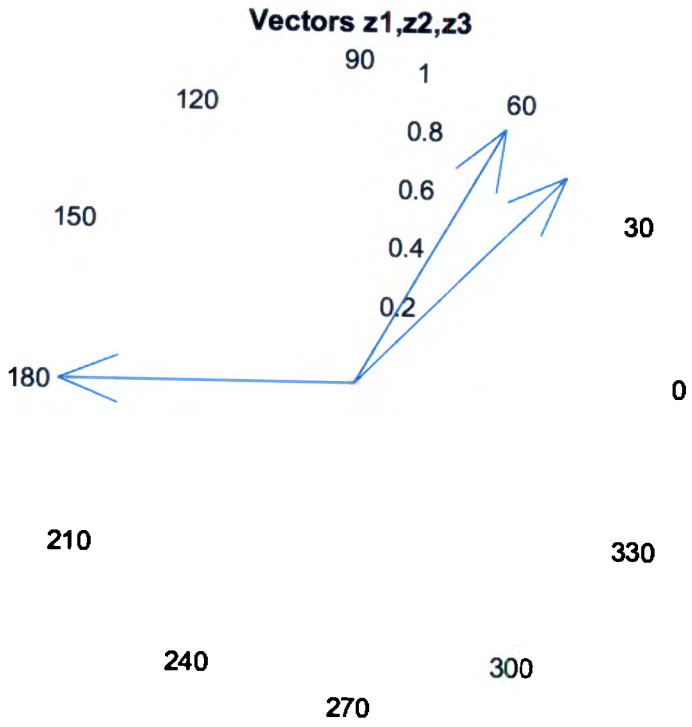

Vectors z1,z2,z3
90
1
120
60
0.8
0.6
150
30
0.4
0.2
180
0
210
330
240
300
270

Figure 3

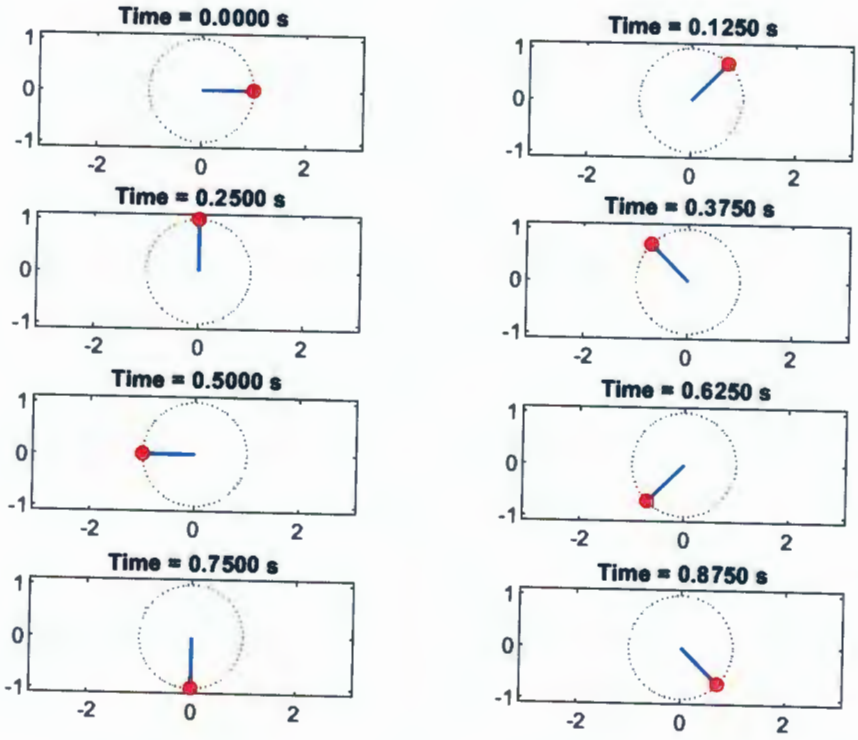

Time = 0.0000 s
Time = 0.1250 s
Time = 0.2500 s
Time = 0.3750 s
Time = 0.5000 s
Time = 0.6250 s
Time = 0.7500 s
Time = 0.8750 s

Figure 4

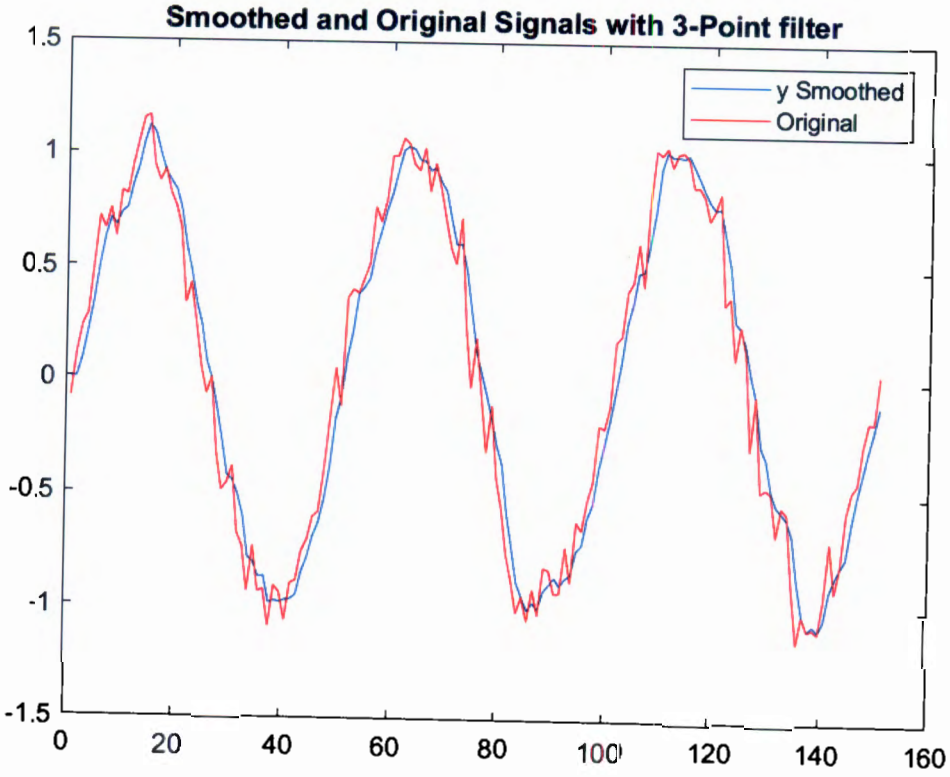
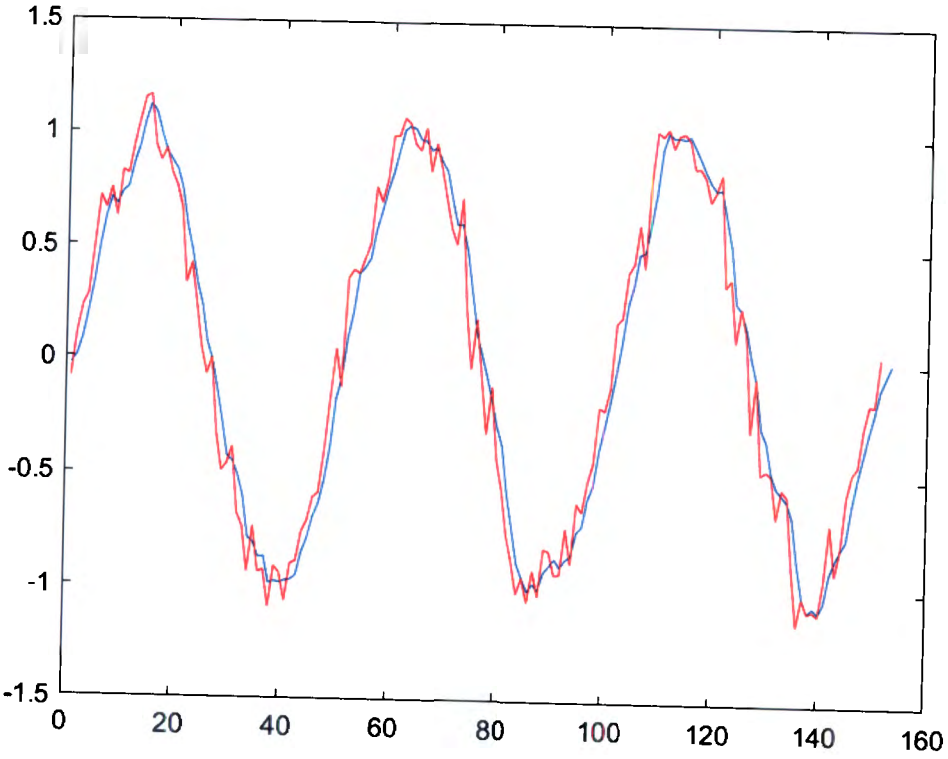

Smoothed and Original Signals with 3-Point filter
y Smoothed
Original
1.5
1
0.5
0
-0.5
-1
-1.5
0
20
40
60
80
100
120
140
160

Figure 5



```
1. Basic Math Convert angles
Angle D1ang is 90.000 degrees or  1.571 radians
  Hit a key
Angle R1rad is 2.475 radians or  141.790 degrees
  Hit a keyComplex NumbersComplex Numbers 0+j*1 to Polar
Magnitude rhoex is 1.000 and angle is 1.571 rad
  Hit a key- See Compass Plot  Hit a key
2. Complex Numbers
z1arg =     3.1416

z2exp =    0.7071 + 0.7071i

z2argpi =     0.2500

z2 =    0.7071 + 0.7071i

z3 =    0.5000 + 0.8660i

z3arg =     1.0472

z3argpi =     0.3333

xvec =    -1.0000    0.7071    0.5000

yvec =      0    0.7071    0.8660
3 Magnitude
z3mag =   5

z3mag2 =   5
4. Addition
x1 =   0.5000

y1 =     0.8660

x2 =     -1

y2 =    1.2246e-16

zaddex =   -0.5000 + 0.8660i

thetazaddex =     2.0944

rhozaddex =    1
 Problems
x4_1 =     1.0000

y4_1 =    1
```

```
x4_12 =     1.0000

y4_12 =     -1

zadd4_1 =  2.0000

thetaz4_1 =    0

rhoz4_1 =  2.0000

x4_2 =  -1.5576

y4_2 =    6.8245

x4_22 =    0.7116

y4_22 =  -4.9491

zadd4_2 =  -0.8461 + 1.8754i

thetaz4_2 =   1.9946

rhoz4_2 =    2.0574

Ts =    0.1250

h =    0.3333    0.3333    0.3333

Current plot held
Current plot held
diary off
```