Table of Contents

Matlab Series Workshop

Week 1: Data Visualization (Plots) Kan Kanjanapas (Ph.D)

```
clc;
close all;
clear all;


% 1. Plot

fs = 100;      % Sampling Frequency [Hz]
Ts = 1/fs;      % Sampling Time [s]

t_vec = [0:Ts:5]';  % Vector of time stamps

% sinusoidal waveform: A*sin(omega*t + phase_shift)

% Assume the reading from sensor A is given by:
f_1 = 1;

x_1 = 1*sin(2*pi*f_1*t_vec + 0);
x_2 = 2*sin(2*pi*f_1*t_vec + 0);
x_3 = 3*sin(2*pi*f_1*t_vec + 0);
x_4 = 4*sin(2*pi*f_1*t_vec + 0);
x_5 = 5*sin(2*pi*f_1*t_vec + 0);

x_ceil = [];
for ii = 1:5
    x_ceil{ii} = ii*sin(2*pi*f_1*t_vec + 0);
end
```

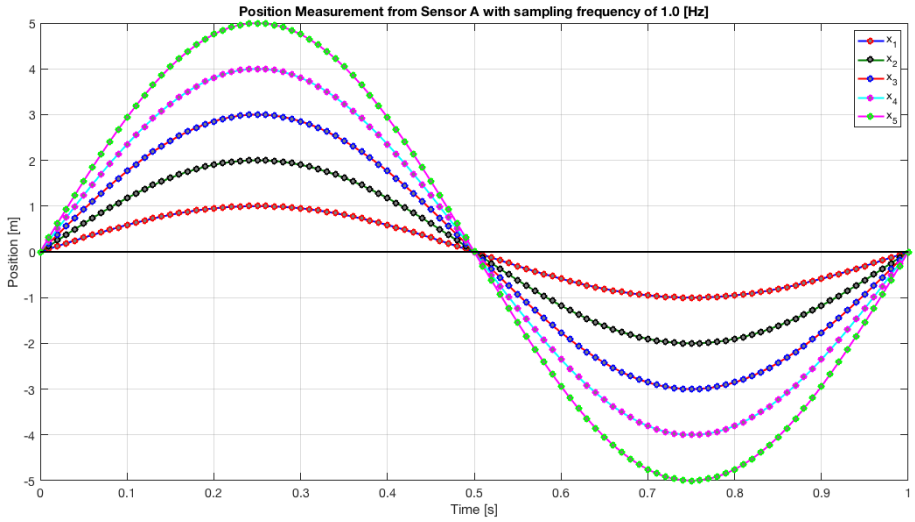
1) Plot

```
% Your first plot
figure;
plot(t_vec, x_1);
```

```
% Refine the first plot 1.0
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);
plot(t_vec, x_1);
xlabel('Time [s]');
ylabel('Position [m]');
title('Position Measurement from Sensor A');
grid on;


% Refine the first plot: version 1.1
 ------------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);
plot(t_vec, x_1, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.0
 1.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'r', 'MarkerFaceColor', 'y');
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
grid on;
set(gca, 'FontSize', 14);



% Refine the first plot: version 1.2
 ------------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);
plot(t_vec, x_1, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.0
 1.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'r', 'MarkerFaceColor', 'y');
hold on; %
 ***********************************************************
plot(t_vec, x_2, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.5
 0.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'k', 'MarkerFaceColor', 'g');
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
h_legend = legend('x_1', 'x_2');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);



% Refine the first plot: version 1.3
 ------------------------------------------------------------------------------
Color_Matrix = [0.0  0.0  1.0;
                0.0  0.5  0.0;
                1.0  0.0  0.0;
```

```
                0.0  1.0  1.0;
                1.0  0.0  1.0];

MarkerEdgeColor_Ceil = {'r', 'k', 'b', 'm', 'g'};

figure;
set(gcf, 'Position', [0 0 2560 1280]/2);
for ii = 1:5 %
 ************************************************************

    plot(t_vec, x_ceil{ii}, 'LineStyle', '-', 'LineWidth', 2, 'Color',
 Color_Matrix(ii,:), ...
     'Marker', 'o', 'MarkerEdgeColor',
 MarkerEdgeColor_Ceil{ii}, 'MarkerFaceColor', 0.5*[1 1 1]);
    if (ii == 1)
        hold on;
    end
end
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
h_legend = legend('x_1', 'x_2', 'x_3', 'x_4', 'x_5'); %
 ************************************************************
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);



% Refine the first plot: version 1.4
 ------------------------------------------------------------------------------
Color_Matrix = [0.0  0.0  1.0;
                0.0  0.5  0.0;
                1.0  0.0  0.0;
                0.0  1.0  1.0;
                1.0  0.0  1.0];

MarkerEdgeColor_Ceil = {'r', 'k', 'b', 'm', 'g'};
close all;
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);
for ii = 1:5
    plot(t_vec, x_ceil{ii}, 'LineStyle', '-', 'LineWidth', 2, 'Color',
 Color_Matrix(ii,:), ...
     'Marker', 'o', 'MarkerEdgeColor',
 MarkerEdgeColor_Ceil{ii}, 'MarkerFaceColor', 0.5*[1 1 1]);
    if (ii == 1)
        hold on;
    elseif (ii == 5)
        line([0 max(t_vec)], [0 0], 'LineStyle', '-', 'LineWidth',
 2, 'Color', 'k');  % ***************
    end
```

```
end
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
h_legend = legend('x_1', 'x_2', 'x_3', 'x_4', 'x_5');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);
axis([0 1 min(x_ceil{5}) max(x_ceil{5})]);
```



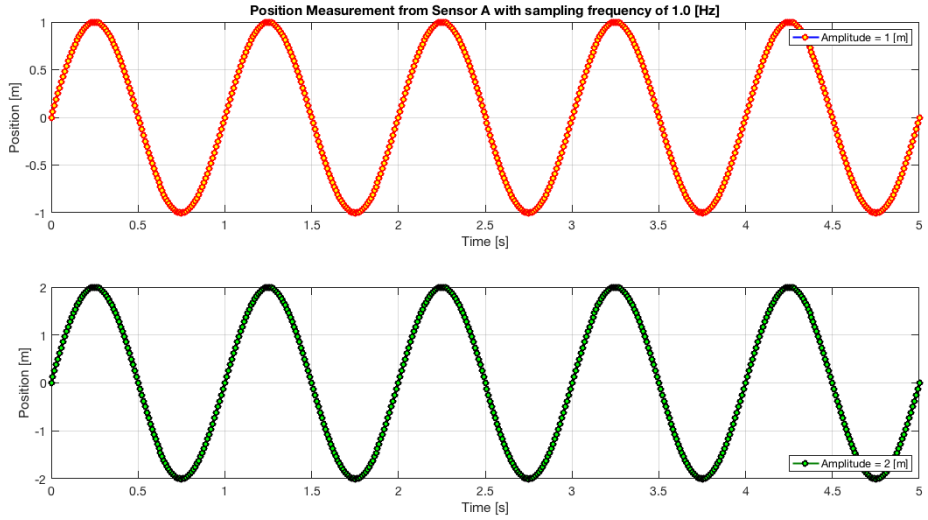
2) Subplot

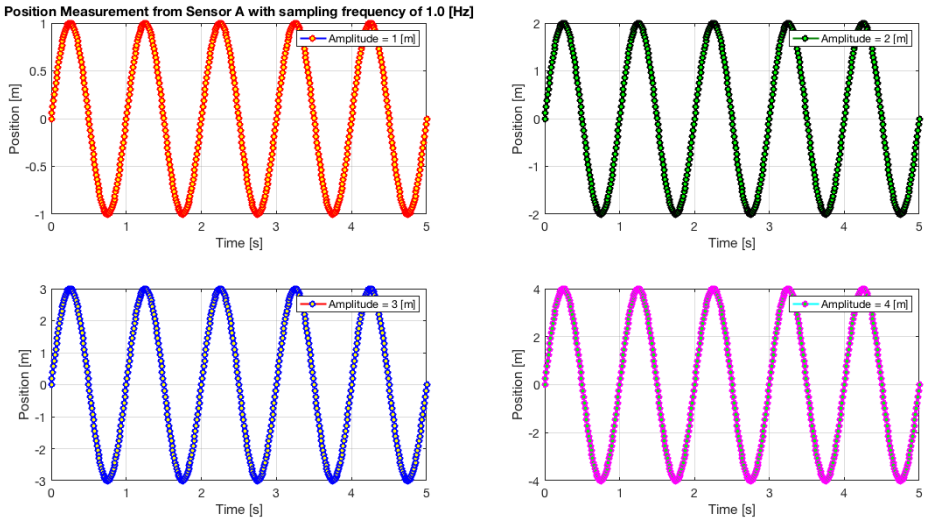
```
% Subplot Version 2.1
 ------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);

subplot(2,1,1);
plot(t_vec, x_1, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.0
 1.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'r', 'MarkerFaceColor', 'y');
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
h_legend = legend('Amplitude = 1 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);

subplot(2,1,2);
plot(t_vec, x_2, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.5
 0.0], ...
```

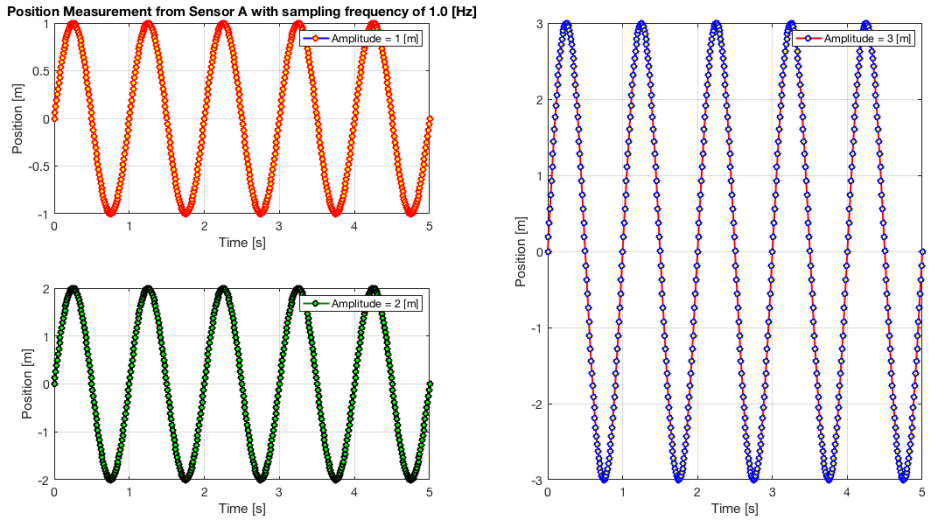
```
     'Marker', 'o', 'MarkerEdgeColor', 'k', 'MarkerFaceColor', 'g');
xlabel('Time [s]');
ylabel('Position [m]');
h_legend = legend('Amplitude = 2 [m]');
set(h_legend, 'Location', 'SouthEast', 'Color', [1.0  1.0  0.9]);
%title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
grid on;
set(gca, 'FontSize', 14);



% Subplot Version 2.2
 ------------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);


subplot(2,2,1);
plot(t_vec, x_1, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.0
 1.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'r', 'MarkerFaceColor', 'y');
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
h_legend = legend('Amplitude = 1 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);


subplot(2,2,2);
plot(t_vec, x_2, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.5
 0.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'k', 'MarkerFaceColor', 'g');
xlabel('Time [s]');
ylabel('Position [m]');
h_legend = legend('Amplitude = 2 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
%title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
grid on;
set(gca, 'FontSize', 14);

subplot(2,2,3);
plot(t_vec, x_3, 'LineStyle', '-', 'LineWidth', 2, 'Color',
 Color_Matrix(3,:), ...
     'Marker', 'o', 'MarkerEdgeColor',
 MarkerEdgeColor_Ceil{3}, 'MarkerFaceColor', 'y');
xlabel('Time [s]');
ylabel('Position [m]');
h_legend = legend('Amplitude = 3 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
```

```
grid on;
set(gca, 'FontSize', 14);


subplot(2,2,4);
plot(t_vec, x_4, 'LineStyle', '-', 'LineWidth', 2, 'Color',
 Color_Matrix(4,:), ...
     'Marker', 'o', 'MarkerEdgeColor',
 MarkerEdgeColor_Ceil{4}, 'MarkerFaceColor', 'g');
xlabel('Time [s]');
ylabel('Position [m]');
h_legend = legend('Amplitude = 4 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
%title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
grid on;
set(gca, 'FontSize', 14);



% Subplot Version 2.3
 ------------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);


subplot(2,2,1);
plot(t_vec, x_1, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.0
 1.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'r', 'MarkerFaceColor', 'y');
xlabel('Time [s]');
ylabel('Position [m]');
title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
h_legend = legend('Amplitude = 1 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);


subplot(2,2,3);
plot(t_vec, x_2, 'LineStyle', '-', 'LineWidth', 2, 'Color', [0.0  0.5
 0.0], ...
     'Marker', 'o', 'MarkerEdgeColor', 'k', 'MarkerFaceColor', 'g');
xlabel('Time [s]');
ylabel('Position [m]');
h_legend = legend('Amplitude = 2 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
%title(sprintf('Position Measurement from Sensor A with sampling
 frequency of %.1f [Hz]', f_1));
grid on;
set(gca, 'FontSize', 14);

subplot(2,2,[2 4]);
```

```
plot(t_vec, x_3, 'LineStyle', '-', 'LineWidth', 2, 'Color',
 Color_Matrix(3,:), ...
     'Marker', 'o', 'MarkerEdgeColor',
 MarkerEdgeColor_Ceil{3}, 'MarkerFaceColor', 'y');
xlabel('Time [s]');
ylabel('Position [m]');
h_legend = legend('Amplitude = 3 [m]');
set(h_legend, 'Location', 'NorthEast', 'Color', [1.0  1.0  0.9]);
grid on;
set(gca, 'FontSize', 14);
```



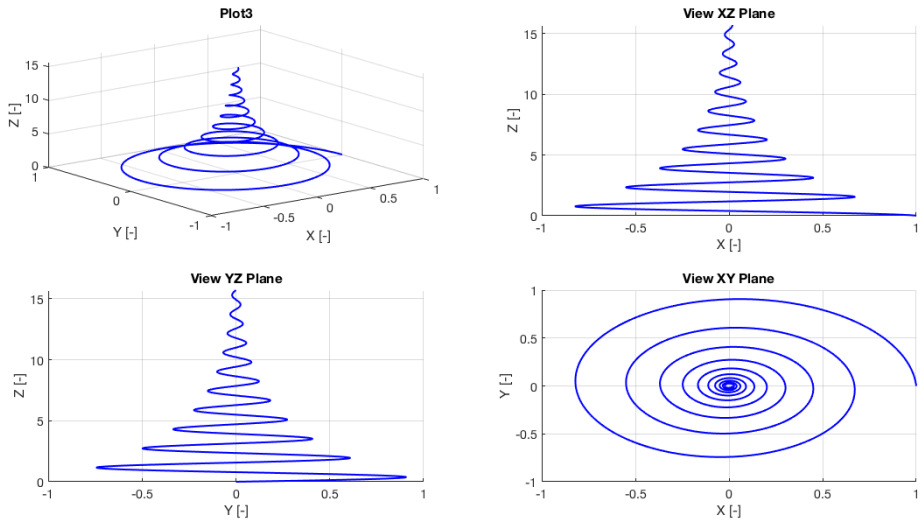




3) Plot3

```
theta  = [0:pi/100:20*pi]';
t_vec2 = [0:1:length(theta)-1]'*Ts;
lambda = 0.2;

r = exp(-lambda*t_vec2);
x = r.*cos(theta);
y = r.*sin(theta);
z = theta/4;

% 3.1: Plot3
 ---------------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);
plot3(x,y,z, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Plot3');
set(gca, 'FontSize', 14);
grid on;


% 3.2: Plot3 Multiple View
 ---------------------------------------------------------------------------------
close all;
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);

subplot(2,2,1);
plot3(x,y,z, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
```

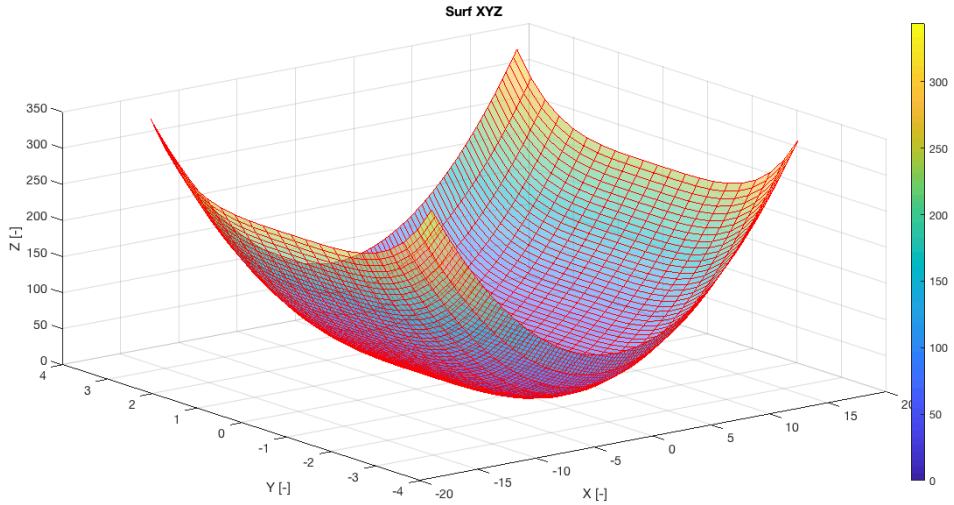
```
zlabel('Z [-]');
title('Plot3');
set(gca, 'FontSize', 14);
grid on;

subplot(2,2,2);
plot3(x,y,z, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('View XZ Plane');
set(gca, 'FontSize', 14);
grid on;
view(0,0);

%
 ------------------------------------------------------------------------
subplot(2,2,3);
plot3(x,y,z, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('View YZ Plane');
set(gca, 'FontSize', 14);
grid on;
view(90,0);

subplot(2,2,4);
plot3(x,y,z, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('View XY Plane');
set(gca, 'FontSize', 14);
grid on;
view(0,90);
```



4) Surface

```
[X,Y] = meshgrid((-5:0.1:5)*pi, (-1:0.1:1)*pi);  % check size(X),
 size(Y)
Z = X.^2 + Y.^4;  % check size(Z)


% 4.1) Surf
 ------------------------------------------------------------------------
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);

surf(X,Y,Z);
colorbar;
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Surf XYZ');
set(gca, 'FontSize', 14);
grid on;


% 4.2) Surf (Cont)
 ------------------------------------------------------------------------
close all;
figure;
set(gcf, 'Position', [0 0 2560 1280]/2);

S = surf(X,Y,Z, 'FaceAlpha', 0.5, 'EdgeColor', 'r');
colorbar;
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Surf XYZ');
```

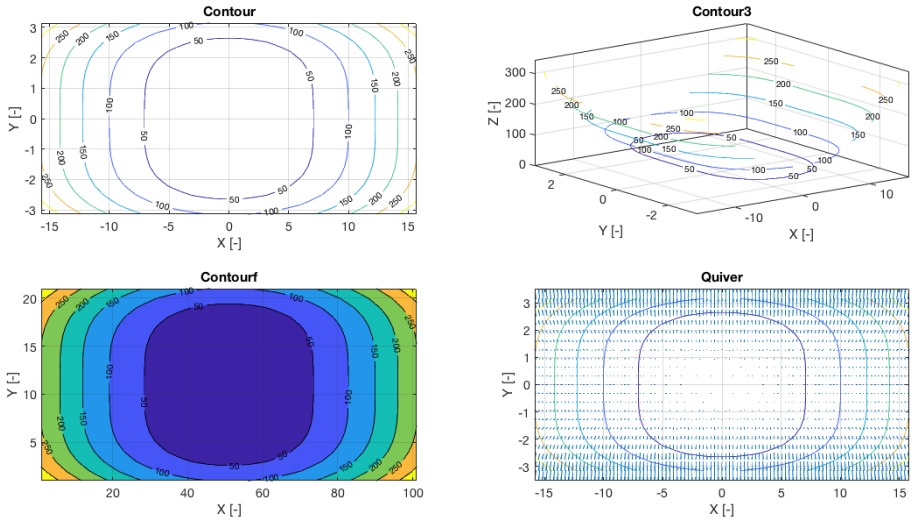
```
set(gca, 'FontSize', 14);
grid on;
```



5) Contour (contour3, countourc, contourf, quiver)

```
% [X,Y] = meshgrid((0:0.1:5)*pi, (0:0.1:1)*pi);  % check size(X),
 size(Y)
% Z = X.^2 + Y.^4;  % check size(Z)

figure;
set(gcf, 'Position', [0 0 2560 1280]/2);

subplot(2,2,1);
contour(X,Y,Z, 'ShowText', 'on');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Contour');
set(gca, 'FontSize', 14);
grid on;


subplot(2,2,2);
contour3(X,Y,Z, 'ShowText', 'on');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Contour3');
set(gca, 'FontSize', 14);
grid on;
```

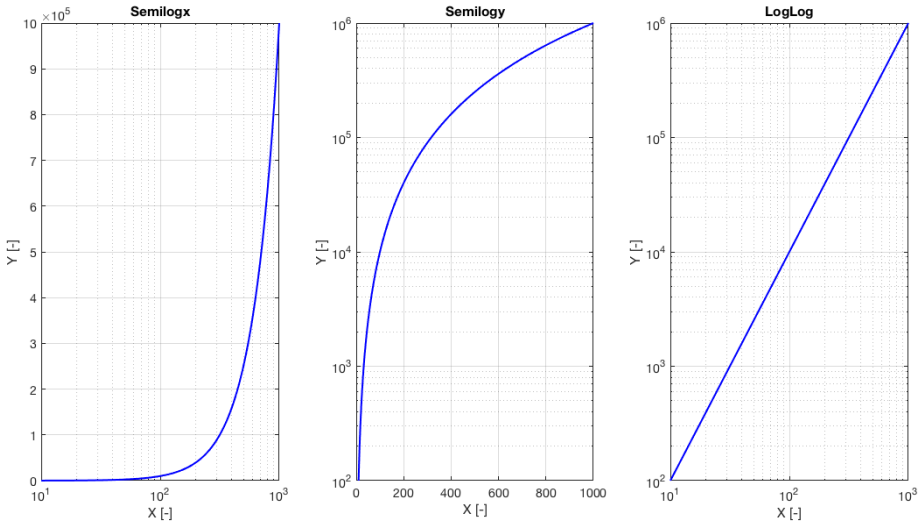
```
subplot(2,2,3);
contourf(Z, 'ShowText', 'on');
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Contourf');
set(gca, 'FontSize', 14);
grid on;

[DX, DY] = gradient(Z,0.2,0.2);
subplot(2,2,4);
contour(X,Y,Z);
hold on;
quiver(X,Y,DX,DY);
hold off;
xlabel('X [-]');
ylabel('Y [-]');
zlabel('Z [-]');
title('Quiver');
set(gca, 'FontSize', 14);
grid on;
```



6) Semilogx, Semilogy, loglog

```
X = logspace(1,3,100);
Y = X.^2;

figure;
set(gcf, 'Position', [0 0 2560 1280]/2);

subplot(1,3,1);
semilogx(X,Y, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
```

```
title('Semilogx');
set(gca, 'FontSize', 14);
grid on;

subplot(1,3,2);
semilogy(X,Y, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
title('Semilogy');
set(gca, 'FontSize', 14);
grid on;

subplot(1,3,3);
loglog(X,Y, 'LineWidth', 2, 'Color', 'b');
xlabel('X [-]');
ylabel('Y [-]');
title('LogLog');
set(gca, 'FontSize', 14);
grid on;
```



Published with MATLAB® R2018a