ME 1020 Engineering Programming with MATLAB

Chapter 6 Homework Solutions: 6.2, 6.7, 6.12, 6.16

Problem 6.2:

2.* In each of the following problems, determine the best function $y(x)$ (linear, exponential, or power function) to describe the data. Plot the function on the same plot with the data. Label and format the plots appropriately.

a.

x	25	30	35	40	45
y	5	260	480	745	1100

b.

x	2.5	3	3.5	4	4.5	5	5.5	6	7	8	9	10
y	1500	1220	1050	915	810	745	690	620	520	480	410	390

c.

x	550	600	650	700	750
y	41.2	18.62	8.62	3.92	1.86

Part a: First plot the original data on rectilinear scales, log-log scales and semi-log y scales.

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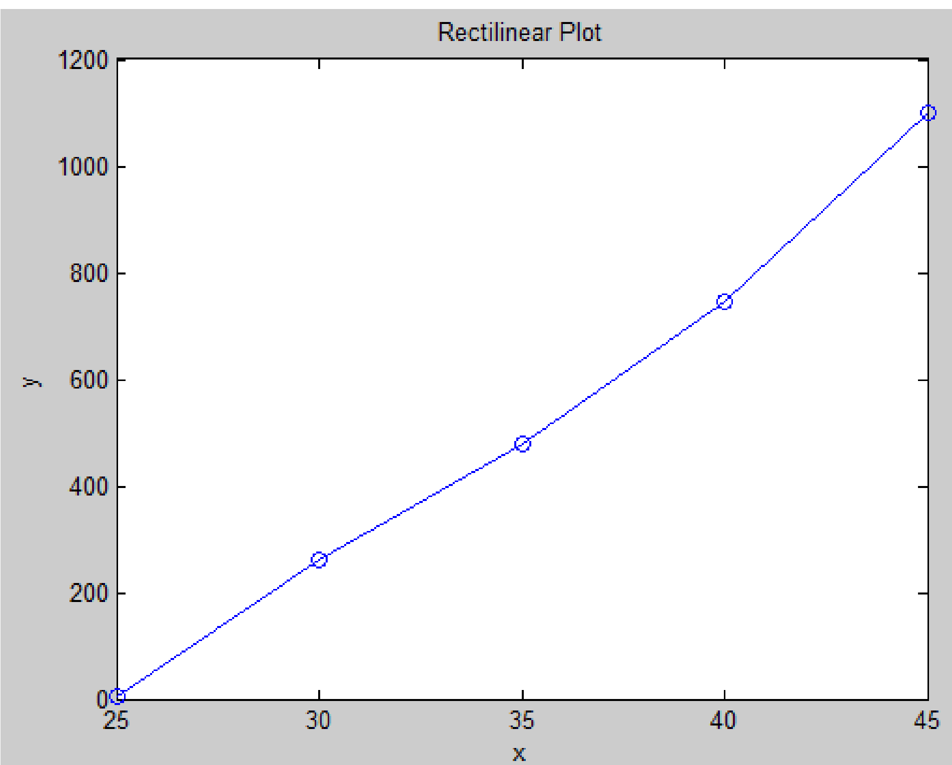
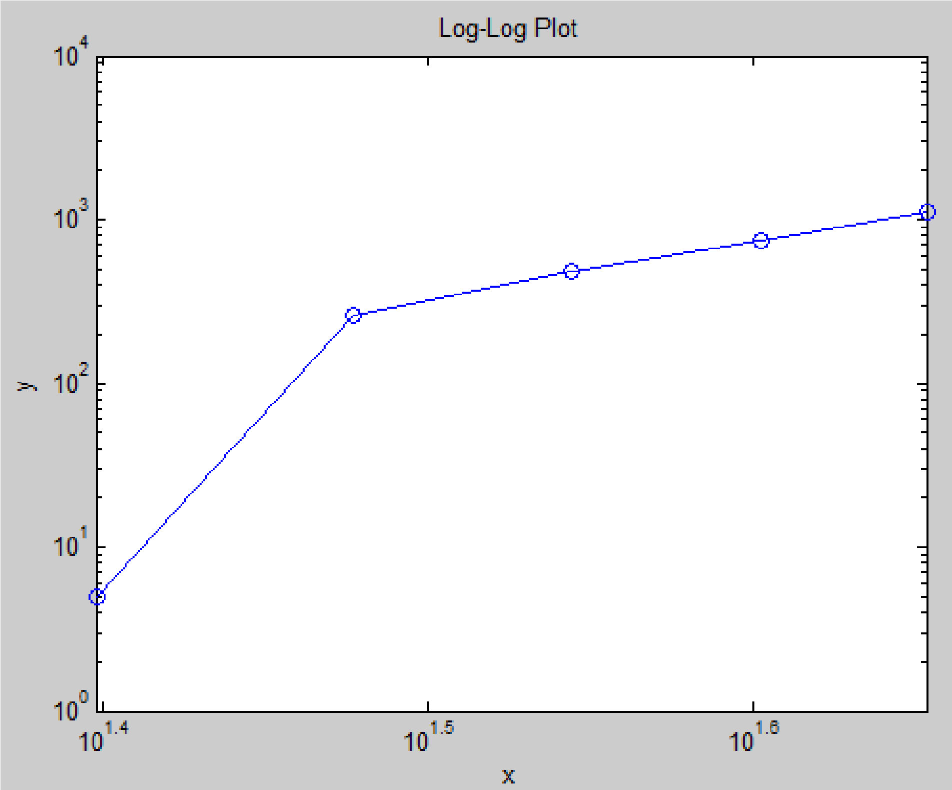
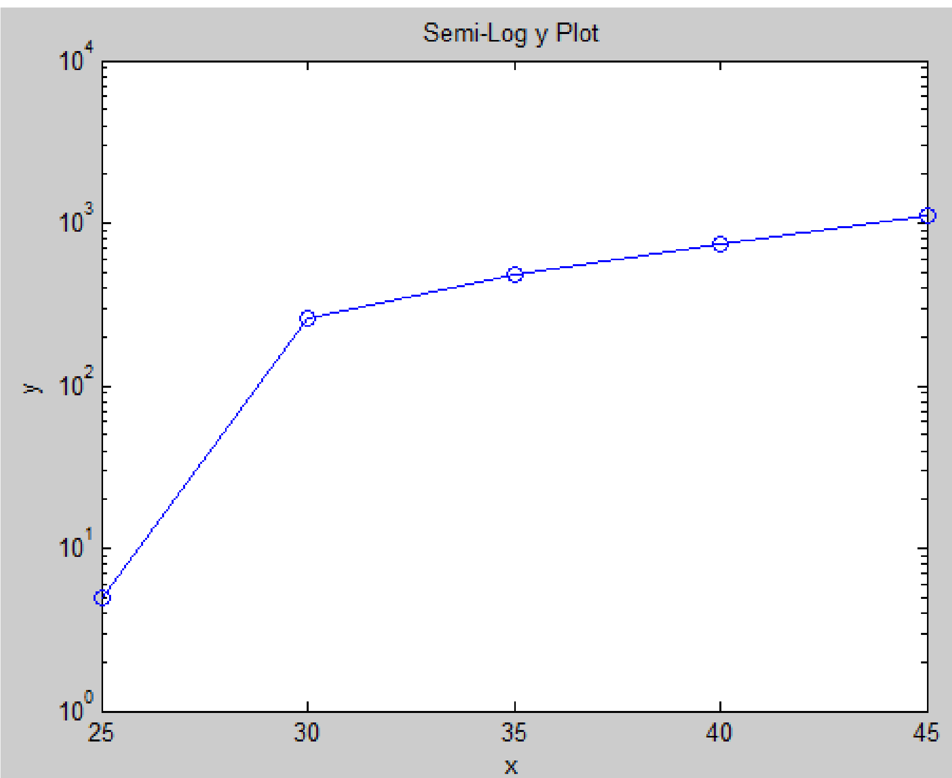
problem6_2a.m*

```
% Problem 6.2a
clear
clc
disp('Problem 6.2a: Scott Thomas')

xa = [25 30 35 40 45];
ya = [5 260 480 745 1100];

figure
plot(xa,ya,'-o')
xlabel('x'), ylabel('y')
title('Rectilinear Plot')
figure
loglog(xa,ya,'-o')
xlabel('x'), ylabel('y')
title('Log-Log Plot')
figure
semilogy(xa,ya,'-o')
xlabel('x'), ylabel('y')
title('Semi-Log y Plot')

```







The plot is most linear on rectilinear scales. Use the **polyfit** command to calculate the **Linear** curve fit. Plot the original data and the curve fit onto rectilinear scales.

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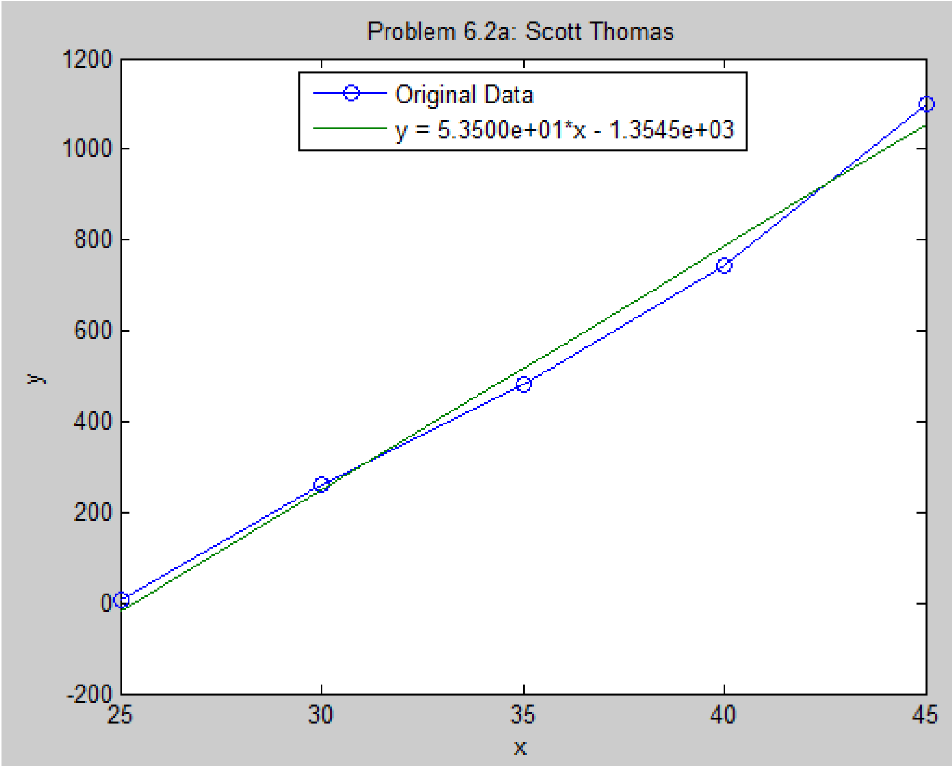
problem6_2a.m

```
    % xlabel('x'), ylabel('y')
    % title('Semi-Log y Plot')

    format short e
    p = polyfit(xa,ya,1)
    ma = p(1)
    ba = p(2)
    N = 10;
    xplot = linspace(25,45,N);
    yplot = ma*xplot + ba;

    figure
    plot(xa,ya,'-o',xplot,yplot)
    xlabel('x'), ylabel('y')
    title('Problem 6.2a: Scott Thomas')
    legend('Original Data','y = 5.3500e+01*x - 1.3545e+03','Location','Best')
```

Command Window

```
Problem 6.2a: Scott Thomas

p =

   5.3500e+01  -1.3545e+03


ma =

   5.3500e+01


ba =

  -1.3545e+03
```

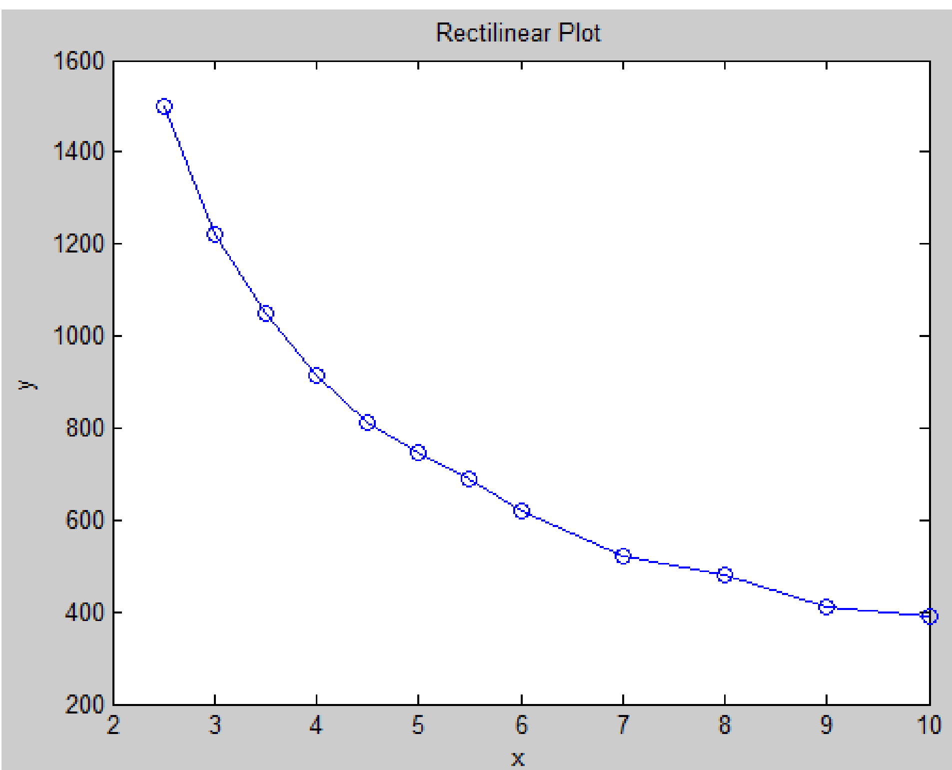

Problem 6.2a: Scott Thomas
Original Data
y = 5.3500e+01*x - 1.3545e+03
1200
1000
800
600
400
200
0
-200
y
25
30
35
40
45
x

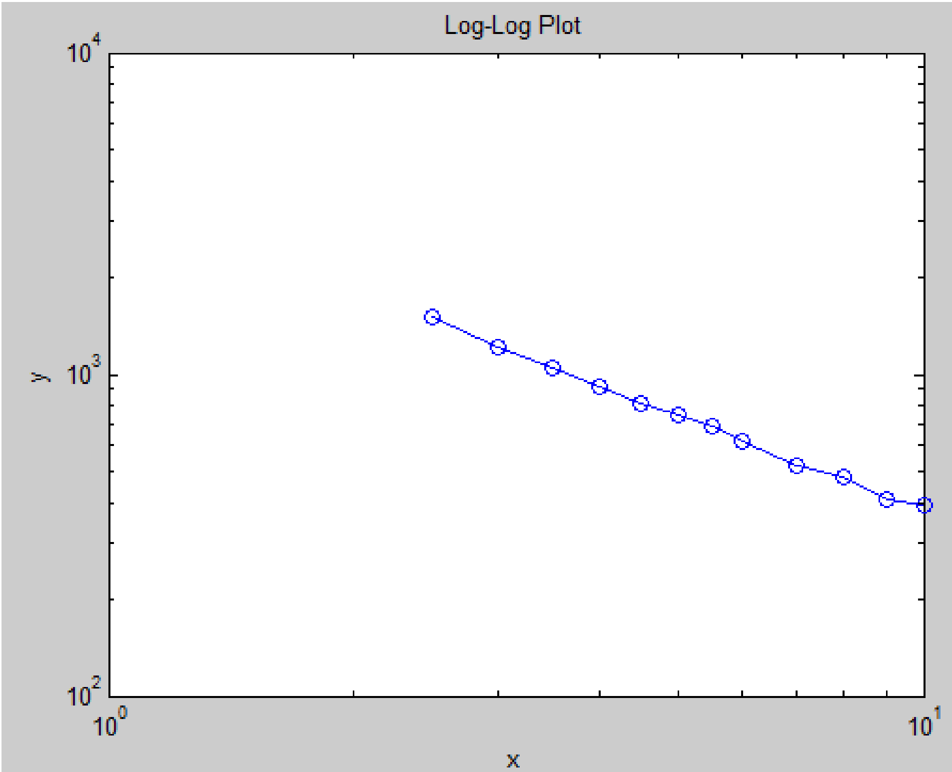
Part b:

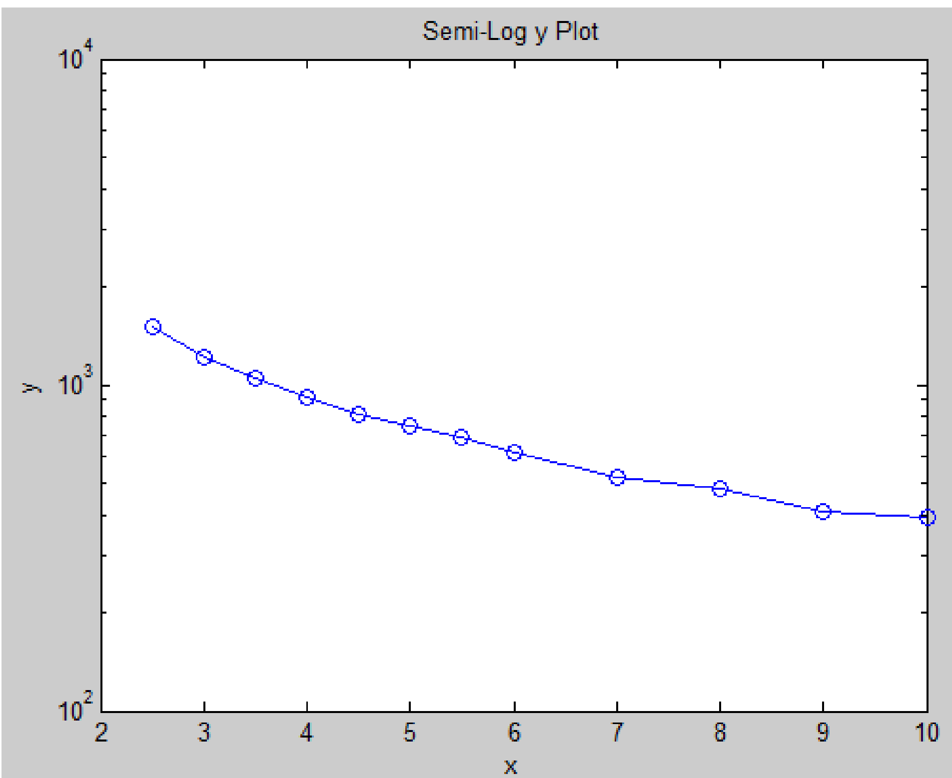
Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 06 Homework\problem6_2b.m

problem6_2b.m | problem6_2.m

```matlab
% Problem 6.2b
clear
clc
disp('Problem 6.2b: Scott Thomas')

xb = [2.5 3 3.5 4 4.5 5 5.5 6 7 8 9 10];
yb = [1500 1220 1050 915 810 745 690 620 520 480 410 390];

figure
plot(xb,yb,'-o')
xlabel('x'), ylabel('y')
title('Rectilinear Plot')
figure
loglog(xb,yb,'-o')
xlabel('x'), ylabel('y')
title('Log-Log Plot')
figure
semilogy(xb,yb,'-o')
xlabel('x'), ylabel('y')
title('Semi-Log y Plot')

```







The plot is most linear on log-log scales. Use the **polyfit** command to calculate the **Power-Law** curve fit. Plot the original data and the curve fit onto rectilinear scales.

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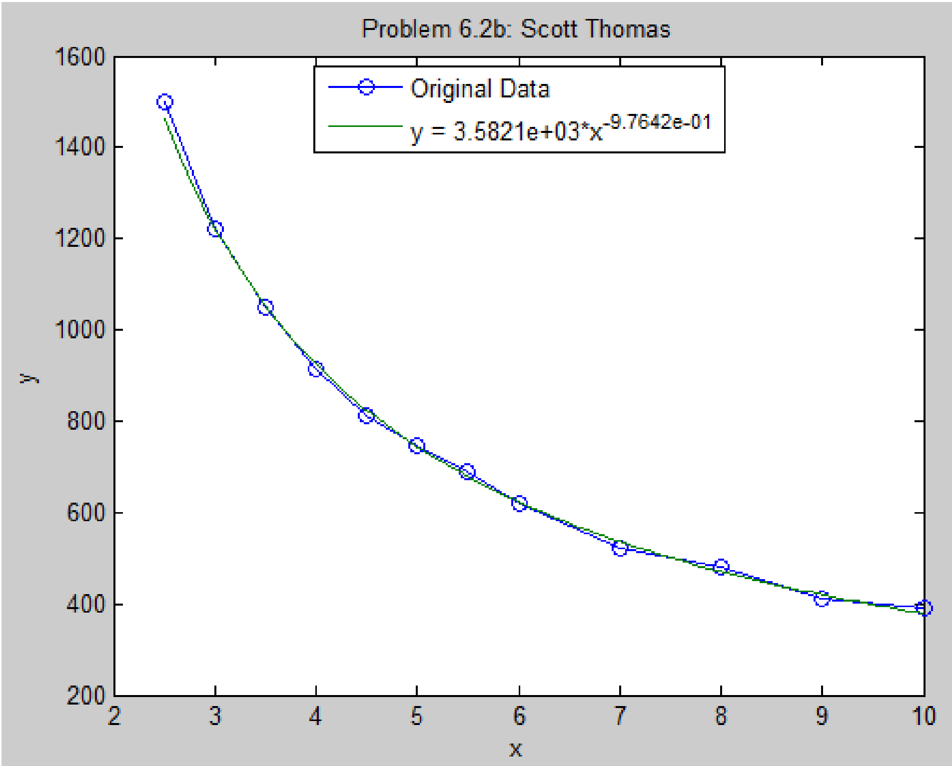
problem6_2b.m*

```
% xlabel('x'), ylabel('y')
% title('Semi-Log y Plot')

format short e
p = polyfit(log10(xb),log10(yb),1)
mb = p(1)
bb = 10^(p(2))
N = 100;
xplot = linspace(2.5,10,N);
yplot = bb*xplot.^mb;


figure
plot(xb,yb,'-o',xplot,yplot)
xlabel('x'), ylabel('y')
title('Problem 6.2b: Scott Thomas')
legend('Original Data','y = 3.5821e+03*x^{-9.7642e-01}','Location','Best')
```

Command Window

```
Problem 6.2b: Scott Thomas

p =

  -9.7642e-01   3.5541e+00


mb =

  -9.7642e-01


bb =

   3.5821e+03
```


Problem 6.2b: Scott Thomas
Original Data
y = 3.5821e+03*x^-9.7642e-01
1600
1400
1200
1000
800
600
400
200
2
3
4
5
6
7
8
9
10
x
y

Part c:

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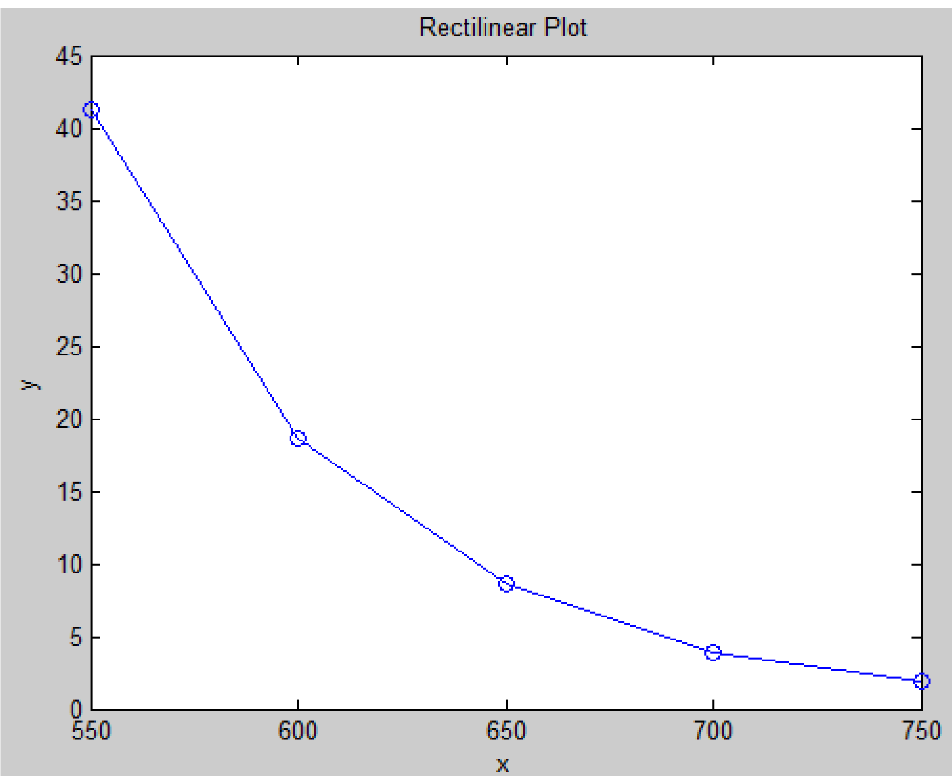
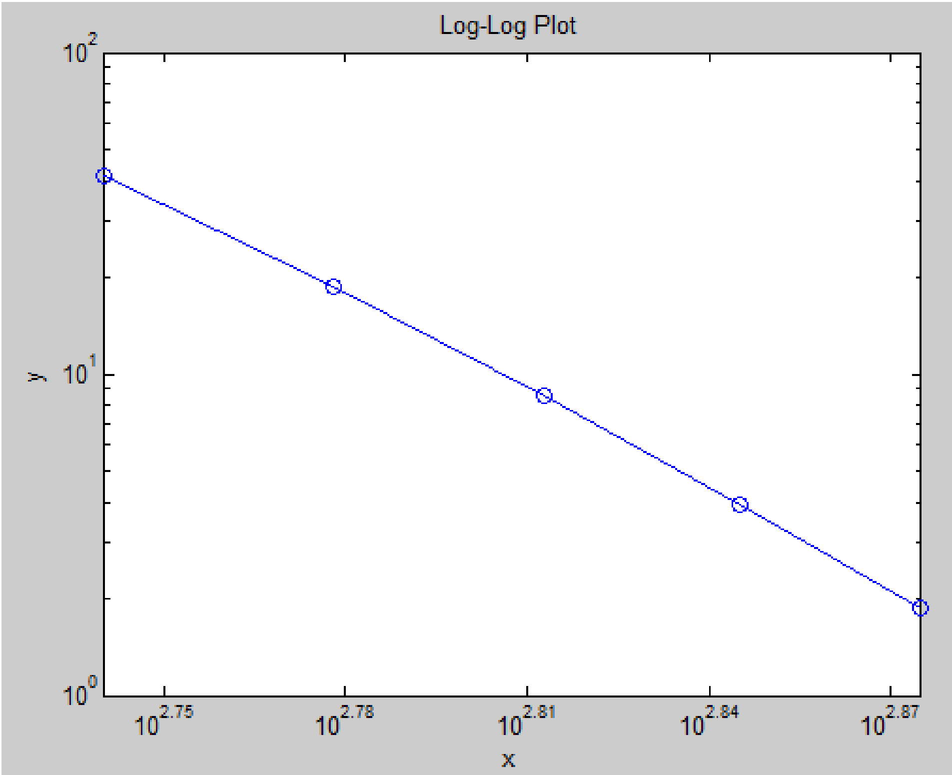
problem6_2c.m

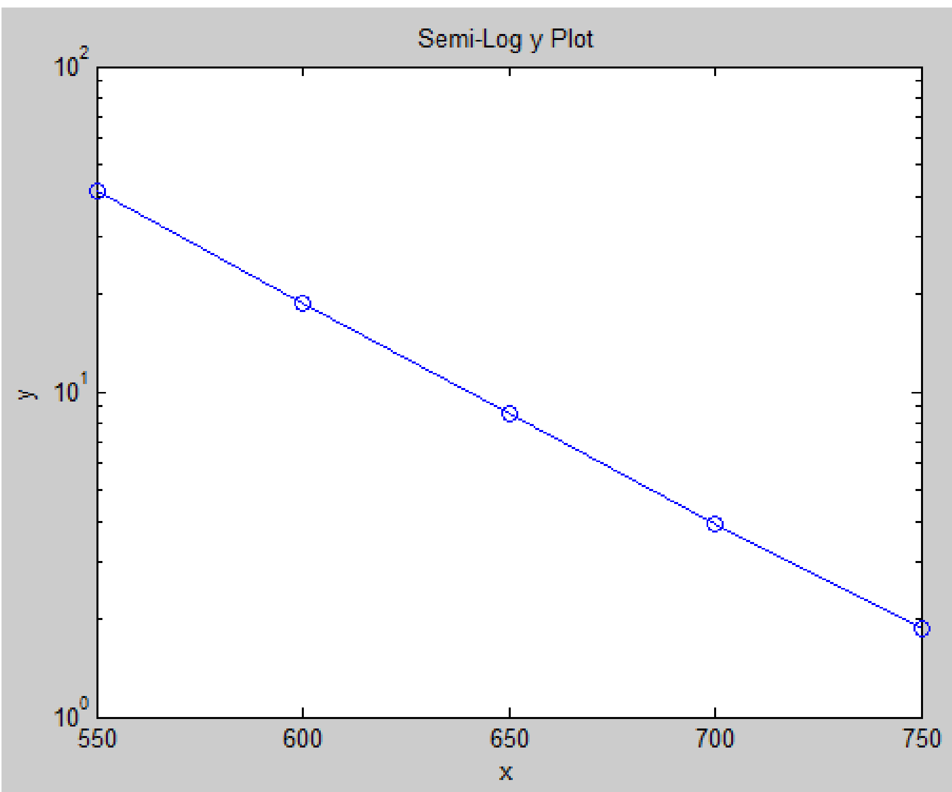
```matlab
% Problem 6.2c
clear
clc
disp('Problem 6.2c: Scott Thomas')

xc = [550 600 650 700 750];
yc = [41.2 18.62 8.62 3.92 1.86];

figure
plot(xc,yc,'-o')
xlabel('x'), ylabel('y')
title('Rectilinear Plot')
figure
loglog(xc,yc,'-o')
xlabel('x'), ylabel('y')
title('Log-Log Plot')
figure
semilogy(xc,yc,'-o')
xlabel('x'), ylabel('y')
title('Semi-Log y Plot')
```







The plot is most linear on semi-log y scales. Use the **polyfit** command to calculate the **Exponential** curve fit. Plot the original data and the curve fit onto rectilinear scales.

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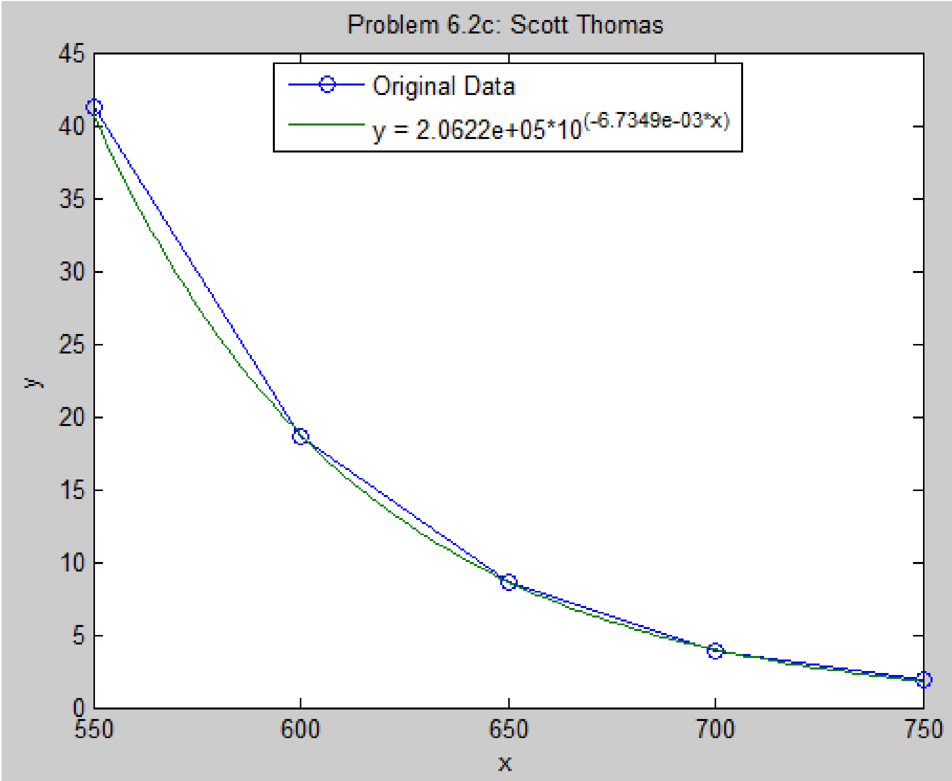
problem6_2c.m

```
% xlabel('x'), ylabel('y')
% title('Semi-Log y Plot')

format short e
p = polyfit(xc,log10(yc),1)
mc = p(1)
bc = 10^(p(2))
N = 100;
xplot = linspace(550,750,N);
yplot = bc*10.^(mc.*xplot);

figure
plot(xc,yc,'-o',xplot,yplot)
xlabel('x'), ylabel('y')
title('Problem 6.2c: Scott Thomas')
legend('Original Data','y = 2.0622e+05*10^{(-6.7349e-03*x)}','Location','Best')
```

Command Window

```
Problem 6.2c: Scott Thomas

p =

  -6.7349e-03   5.3143e+00


mc =

  -6.7349e-03


bc =

   2.0622e+05
```


Problem 6.2c: Scott Thomas
Original Data
y = 2.0622e+05*10^(-6.7349e-03*x)
45
40
35
30
25
20
15
10
5
0
550
600
650
700
750
x
y

Problem 6.7:

7. A certain electric circuit has a resistor and a capacitor. The capacitor is initially charged to 100 V. When the power supply is detached, the capacitor voltage decays with time, as the following data table shows. Find a functional description of the capacitor voltage v as a function of time t. Plot the function and the data on the same plot.

Time (s)	0	0.5	1	1.5	2	2.5	3	3.5
Voltage (V)	100	62	38	21	13	7	4	2

First plot the original data on rectilinear scales, log-log scales and semi-log y scales.

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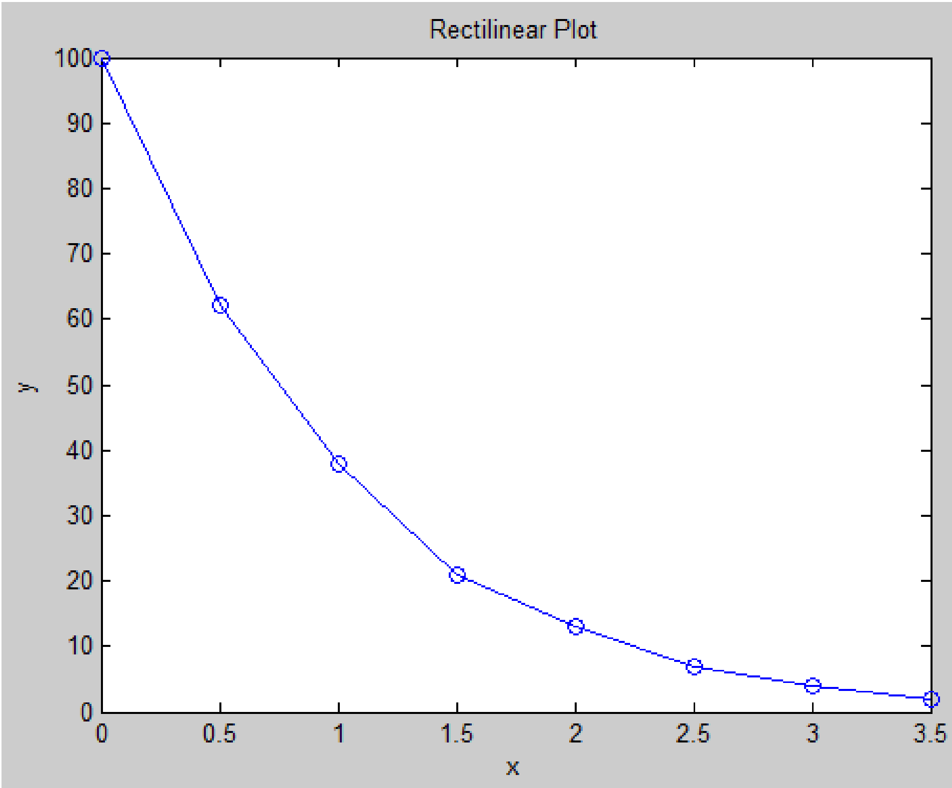
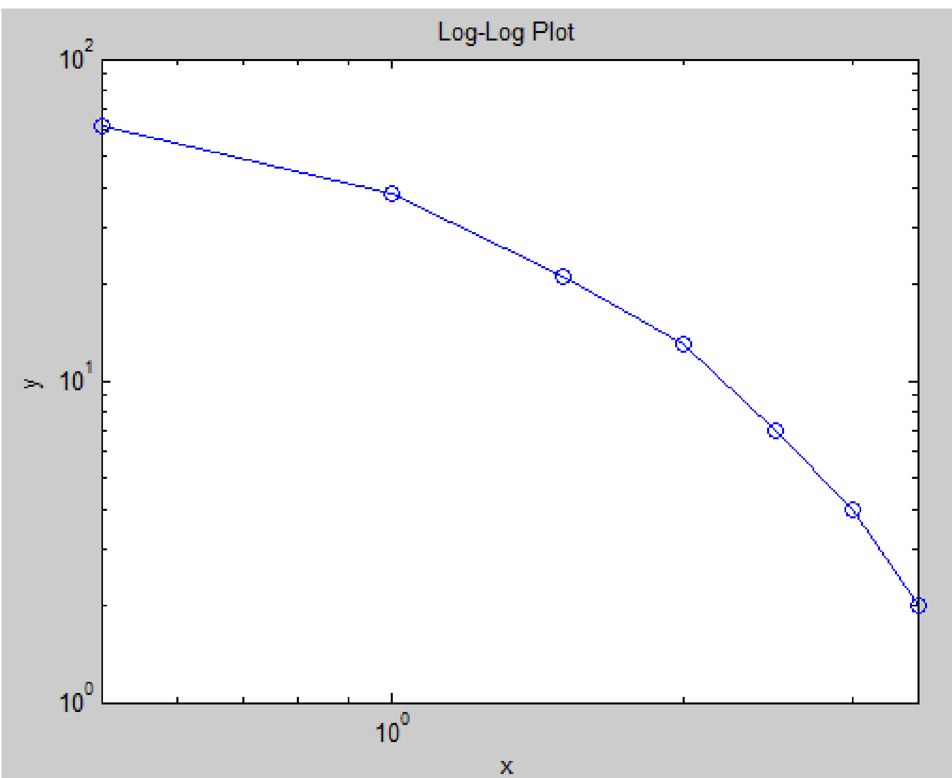
problem6_7.m

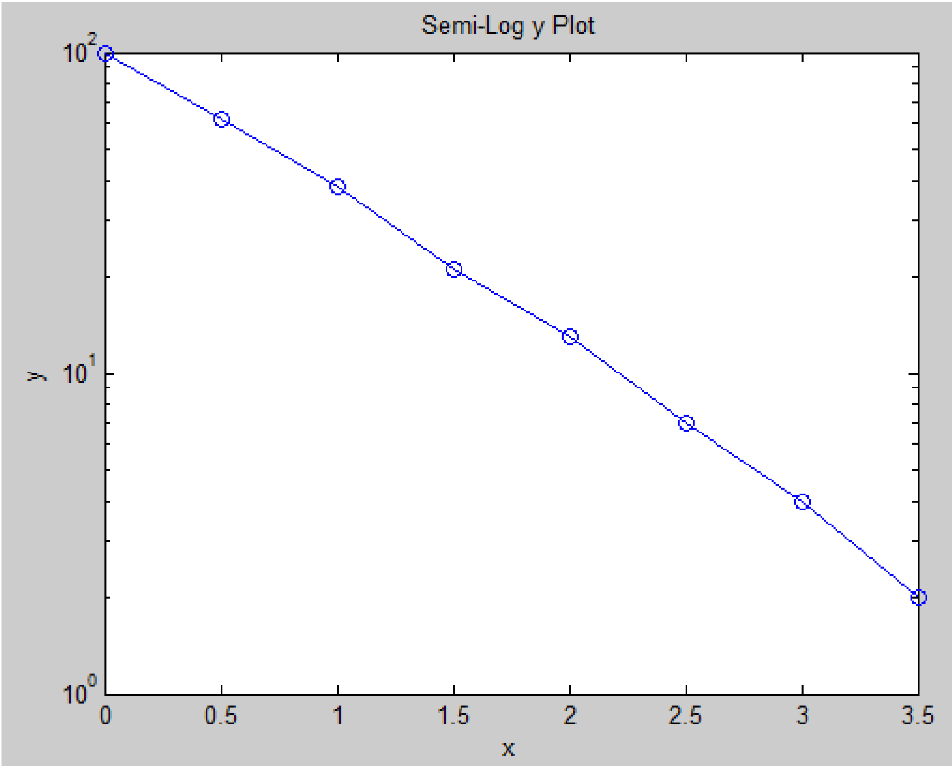
```
% Problem 6.7
clear
clc
disp('Problem 6.7: Scott Thomas')

format shortEng

x = 0:0.5:3.5;
y = [100 62 38 21 13 7 4 2];

figure
plot(x,y,'-o')
xlabel('x'), ylabel('y')
title('Rectilinear Plot')
figure
loglog(x,y,'-o')
xlabel('x'), ylabel('y')
title('Log-Log Plot')
figure
semilogy(x,y,'-o')
xlabel('x'), ylabel('y')
title('Semi-Log y Plot')
```



Rectilinear Plot
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
3.5
x
y



Log-Log Plot
10^2
10^1
10^0
10^0
x
y



The plot is most linear on semi-log y scales. Use the **polyfit** command to calculate the **Exponential** curve fit. Plot the original data and the curve fit onto rectilinear scales.

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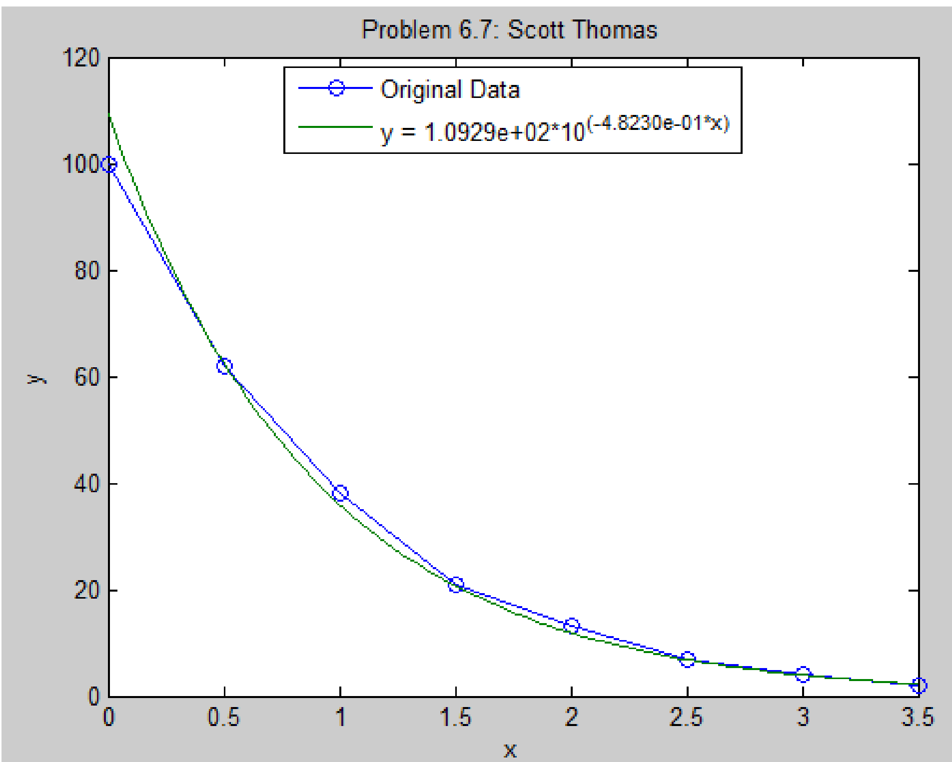
problem6_7.m*

```
% xlabel('x'), ylabel('y')
% title('Semi-Log y Plot')

format short e
p = polyfit(x,log10(y),1)
m = p(1)
b = 10^(p(2))
N = 100;
xplot = linspace(0,3.5,N);
yplot = b*10.^(m.*xplot);

figure
plot(x,y,'-o',xplot,yplot)
xlabel('x'), ylabel('y')
title('Problem 6.7: Scott Thomas')
legend('Original Data','y = 1.0929e+02*10^{(-4.8230e-01*x)}','Location','Best')
```

Command Window

```
Problem 6.7: Scott Thomas

p =

  -4.8230e-01   2.0386e+00


m =

  -4.8230e-01


b =

   1.0929e+02
```



Problem 6.12:

12. The following represents pressure samples, in pounds per square inch (psi), taken in a fuel line once every second for 10 seconds. Fit a first-degree polynomial, a second-degree polynomial, and a third-degree polynomial to these data using the **polyfit** command. Plot the curve fits along with the original data. Use the third-degree polynomial curve fit to provide an estimate of the pressure at *t* = 11 seconds.

Time (sec)	Pressure (psi)	Time (sec)	Pressure (psi)
1	26.1	6	30.6
2	27.0	7	31.1
3	28.2	8	31.3
4	29.0	9	31.0
5	29.8	10	30.5

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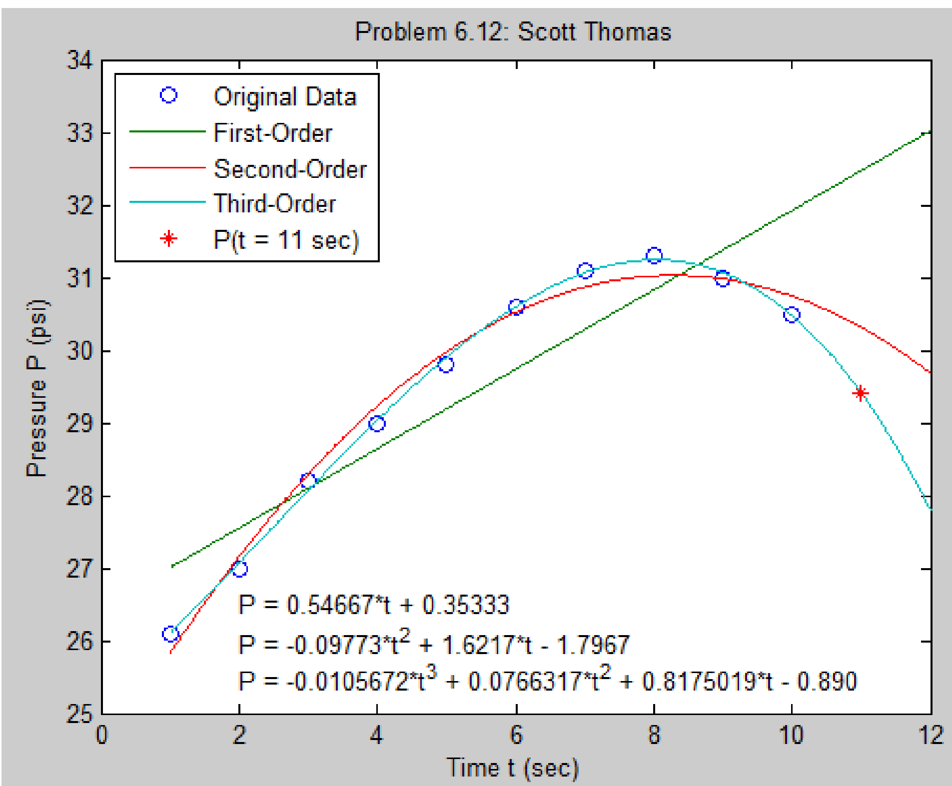
problem6_12_3.m* ×

```
% Problem 6.12
clear
clc
disp('Problem 6.12: Scott Thomas')
format shortEng
time = 1:10;
timeplot = 1:0.01:12;
pressure = [26.1 27 28.2 29 29.8 30.6 31.1 31.3 31 30.5];
%first-order equation:
coeff1 = polyfit(time,pressure,1)
pfit1 = coeff1(1)*time + coeff1(2);
pplot1 = coeff1(1)*timeplot + coeff1(2);
%second-order equation:
coeff2 = polyfit(time,pressure,2)
pfit2 = coeff2(1)*time.^2 + coeff2(2)*time + coeff2(3);
pplot2 = coeff2(1)*timeplot.^2 + coeff2(2)*timeplot + coeff2(3);
%third-order equation:
coeff3 = polyfit(time,pressure,3)
pfit3 = coeff3(1)*time.^3 + coeff3(2)*time.^2 + coeff3(3)*time + coeff3(4);
pplot3 = coeff3(1)*timeplot.^3 + coeff3(2)*timeplot.^2 + coeff3(3)*timeplot + coeff3(4);
%Calculate the pressure at 11 seconds: Use the third-order equation.
time11 = 11;
p_11 = coeff3(1)*time11.^3 + coeff3(2)*time11.^2 + coeff3(3)*time11 + coeff3(4)
figure
plot(time,pressure, 'o', timeplot, pplot1, timeplot, pplot2, timeplot, pplot3,time11,p_11,'r*')
xlabel('Time t (sec)'),
ylabel('Pressure P (psi)'),
title('Problem 6.12: Scott Thomas')
text(2, 26.5, 'P = 0.54667*t + 0.35333')
text(2, 26., 'P = -0.09773*t^2 + 1.6217*t - 1.7967')
text(2, 25.5, 'P = -0.0105672*t^3 + 0.0766317*t^2 + 0.8175019*t - 0.890')
legend('Original Data','First-Order','Second-Order','Third-Order','P(t = 11 sec)','Location','NorthWest')
```

Command Window

```
Problem 6.12: Scott Thomas

coeff1 =

   546.6667e-003    26.4533e+000


coeff2 =

   -97.7273e-003      1.6217e+000     24.3033e+000


coeff3 =

   -10.5672e-003    76.6317e-003    817.5019e-003    25.2100e+000


p_11 =

     29.4100e+000
```



Problem 6.16:

16. The following function is linear in the parameters a_1 and a_2:

$$y(x) = a_1 + a_2 \ln x$$

Use the **polyfit** command with the following data to obtain values for a_1 and a_2. Plot the curve fit on a figure with rectangular scales along with the original data below. Use the curve fit to estimate y at $x = 2.5$ and at $x = 11$.

Use the **Basic Fitting Interface** to determine a fourth-order polynomial fit to the original data and estimate y at $x = 2.5$. Plot the estimate of y at $x = 2.5$ on the figure. Show the equation of the curve fit on the figure using five significant digits. Plot the residuals as a bar plot on a separate figure. Show the norm of the residuals on the figure.

x	1	2	3	4	5	6	7	8	9	10
y	10	14	16	18	19	20	21	22	23	23

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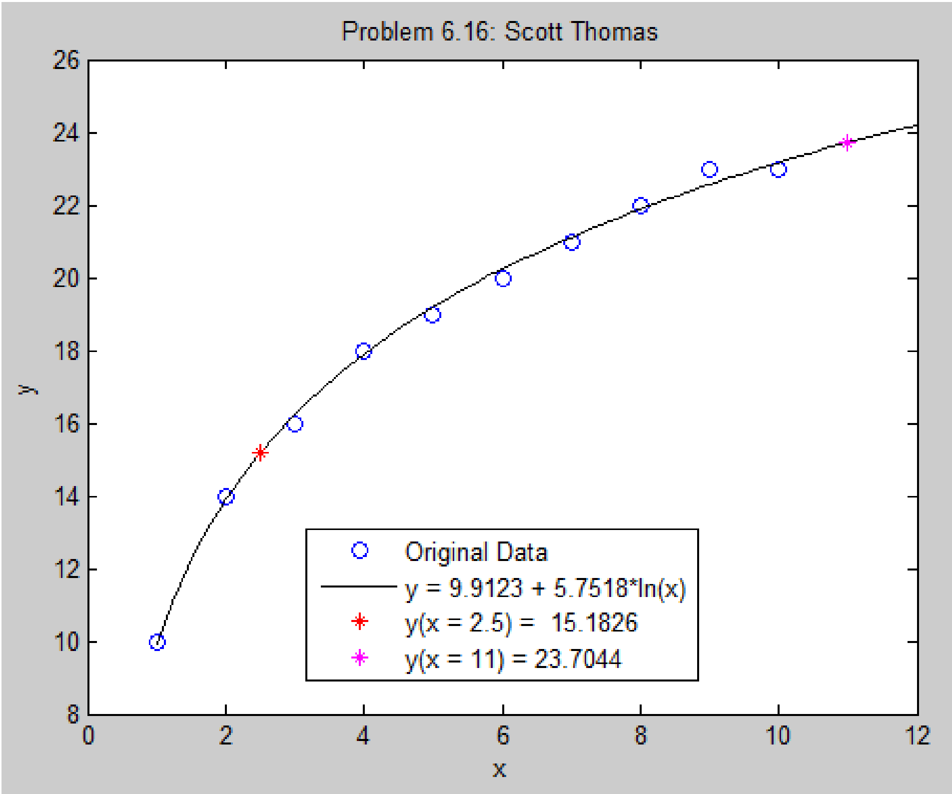
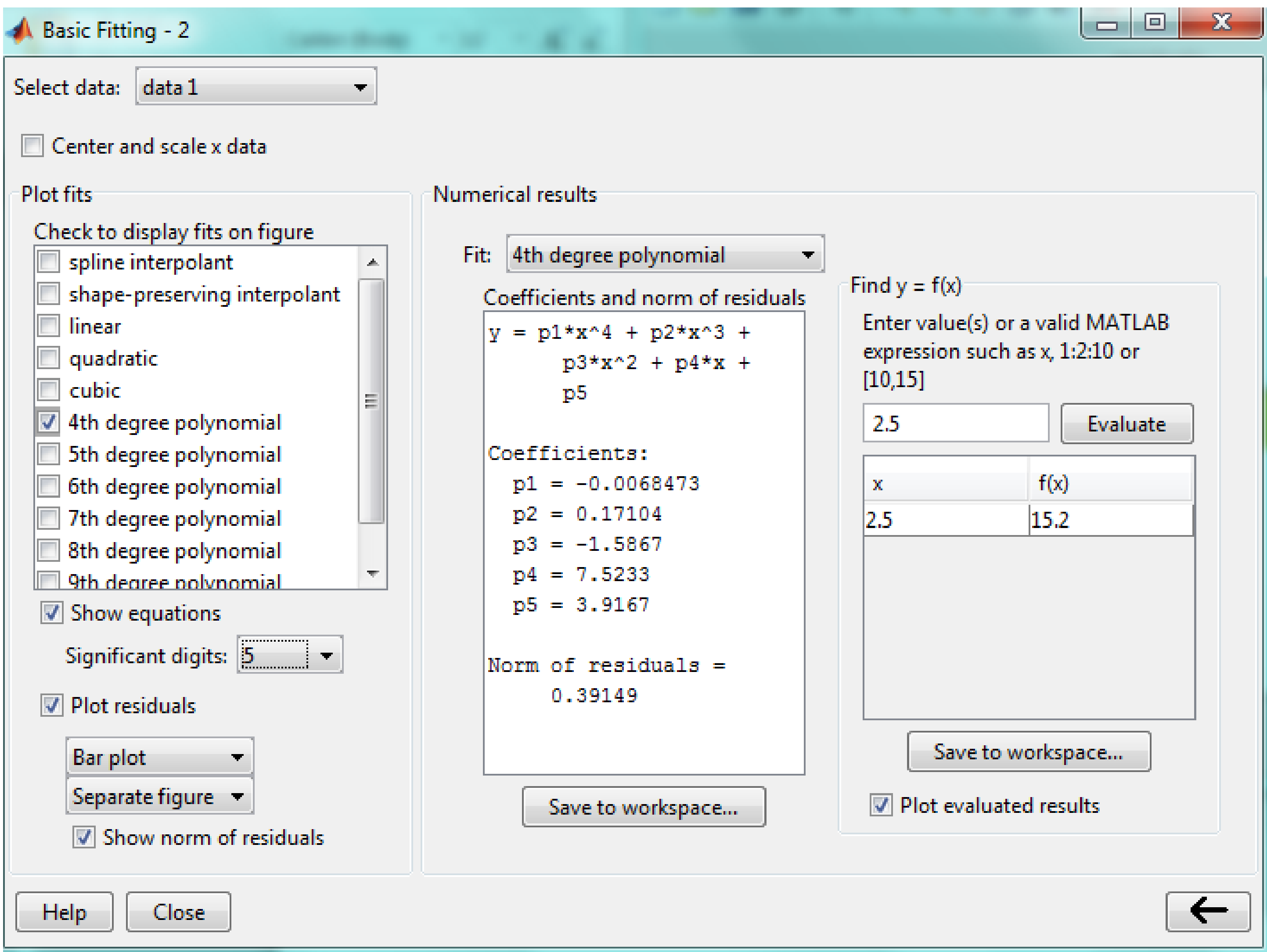
problem6_16.m*

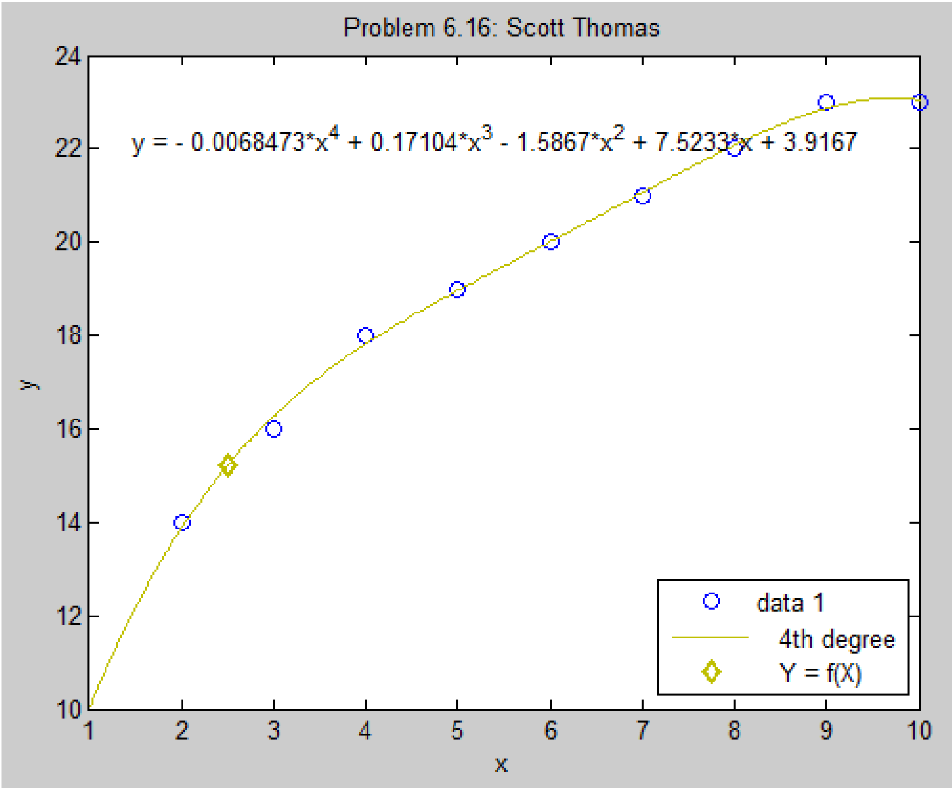
```
% Problem 6.16
clear
clc
disp('Problem 6.16: Scott Thomas')
% y = a_1 + a_2*ln(x)
format shortEng
x = 1:10;
y = [10 14 16 18 19 20 21 22 23 23];% torr
lnx = log(x);
coeff = polyfit(lnx,y,1)
yat2_5 = coeff(1)*log(2.5) + coeff(2)
yat11 = coeff(1)*log(11) + coeff(2)
N = 100;
xplot = linspace(1,12,N);
yplot = coeff(1)*log(xplot) + coeff(2);
figure
plot(x,y, 'o', xplot,yplot, 'k', 2.5, yat2_5, 'r*', 11, yat11, 'm*')
xlabel('x'), ylabel('y'),
title('Problem 6.16: Scott Thomas')
legend('Original Data','y = 9.9123 + 5.7518*ln(x)',...
    'y(x = 2.5) =  15.1826','y(x = 11) = 23.7044', 'Location','Best')
figure
plot(x,y, 'o')
xlabel('x'), ylabel('y'),
title('Problem 6.16: Scott Thomas')
```

Command Window

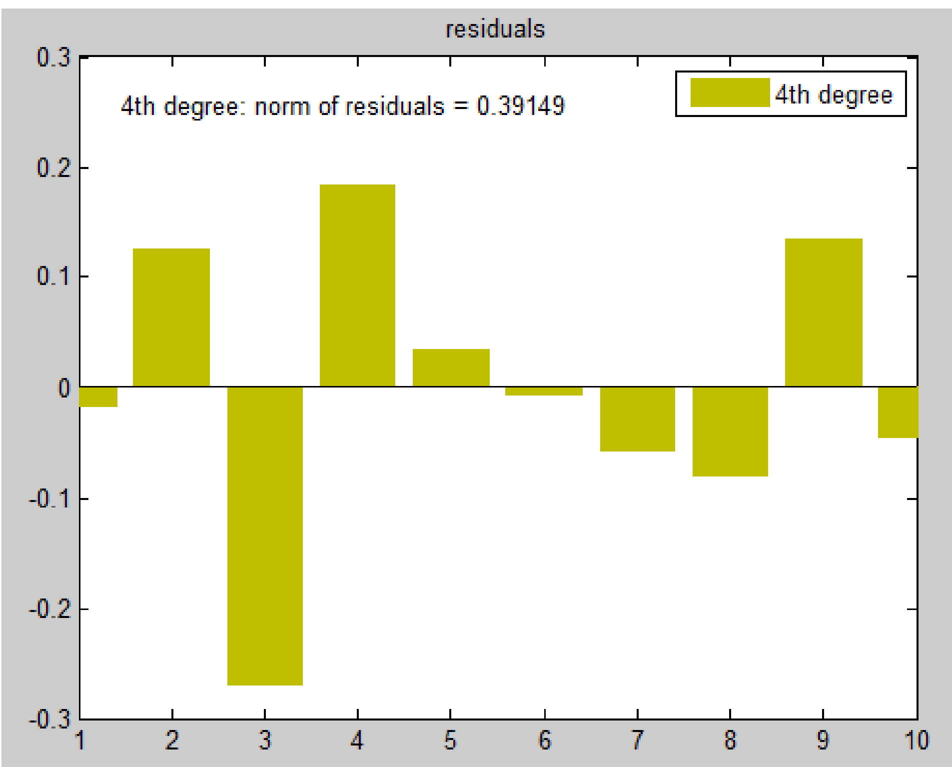
```
Problem 6.16: Scott Thomas

coeff =

     5.7518e+000     9.9123e+000


yat2_5 =

    15.1826e+000


yat11 =

    23.7044e+000
```


Problem 6.16: Scott Thomas
y
x
Original Data
y = 9.9123 + 5.7518*ln(x)
y(x = 2.5) = 15.1826
y(x = 11) = 23.7044
26
24
22
20
18
16
14
12
10
8
0
2
4
6
8
10
12


Basic Fitting - 2
Select data: data 1
Center and scale x data
Plot fits
Check to display fits on figure
spline interpolant
shape-preserving interpolant
linear
quadratic
cubic
4th degree polynomial
5th degree polynomial
6th degree polynomial
7th degree polynomial
8th degree polynomial
9th degree polynomial
Show equations
Significant digits: 5
Plot residuals
Bar plot
Separate figure
Show norm of residuals
Numerical results
Fit: 4th degree polynomial
Coefficients and norm of residuals
y = p1*x^4 + p2*x^3 +
p3*x^2 + p4*x +
p5
Coefficients:
p1 = -0.0068473
p2 = 0.17104
p3 = -1.5867
p4 = 7.5233
p5 = 3.9167
Norm of residuals =
0.39149
Save to workspace...
Find y = f(x)
Enter value(s) or a valid MATLAB expression such as x, 1:2:10 or [10,15]
2.5
Evaluate
x
f(x)
2.5
15.2
Save to workspace...
Plot evaluated results
Help
Close



Problem 6.16: Scott Thomas
y = - 0.0068473*x^4 + 0.17104*x^3 - 1.5867*x^2 + 7.5233*x + 3.9167
data 1
4th degree
Y = f(X)
x
y



residuals
4th degree: norm of residuals = 0.39149
4th degree