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.

<table>
<thead>
<tr>
<th>$x$</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>5</td>
<td>260</td>
<td>480</td>
<td>745</td>
<td>1100</td>
</tr>
</tbody>
</table>

b.

<table>
<thead>
<tr>
<th>$x$</th>
<th>2.5</th>
<th>3</th>
<th>3.5</th>
<th>4</th>
<th>4.5</th>
<th>5</th>
<th>5.5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>1500</td>
<td>1220</td>
<td>1050</td>
<td>915</td>
<td>810</td>
<td>745</td>
<td>690</td>
<td>620</td>
<td>520</td>
<td>480</td>
<td>410</td>
<td>390</td>
</tr>
</tbody>
</table>

c.

<table>
<thead>
<tr>
<th>$x$</th>
<th>550</th>
<th>600</th>
<th>650</th>
<th>700</th>
<th>750</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>41.2</td>
<td>18.62</td>
<td>8.62</td>
<td>3.92</td>
<td>1.86</td>
</tr>
</tbody>
</table>
Part a: First plot the original data on rectilinear scales, log-log scales and semi-log y scales.
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.
% 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')

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

$y = 5.3500e+01 \cdot x - 1.3545e+03$
Part b:

```matlab
% Problem 6.2b

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

xb = [2.5 3.5 4 4.5 5 5.5 6 7 8 9 10];
yb = [1500 1220 1050 915 810 745 690 620 520 480 410 350];

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.
% 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')
Part c:

```matlab
% Problem 6.2c
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 \texttt{polyfit} command to calculate the \textbf{Exponential} curve fit. Plot the original data and the curve fit onto rectilinear scales.
% 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 6.7:

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.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
<th>3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (V)</td>
<td>100</td>
<td>62</td>
<td>38</td>
<td>21</td>
<td>13</td>
<td>7</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

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

```matlab
% 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')
```
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.

```matlab
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')
```
Problem 6.7: Scott Thomas

\[ p = \]
\[-4.8230e-01 \quad 2.0386e+00 \]

\[ m = \]
\[-4.8230e-01 \]

\[ b = \]
\[1.0929e+02\]
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 \texttt{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.

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Pressure (psi)</th>
<th>Time (sec)</th>
<th>Pressure (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26.1</td>
<td>6</td>
<td>30.6</td>
</tr>
<tr>
<td>2</td>
<td>27.0</td>
<td>7</td>
<td>31.0</td>
</tr>
<tr>
<td>3</td>
<td>28.2</td>
<td>8</td>
<td>31.3</td>
</tr>
<tr>
<td>4</td>
<td>29.0</td>
<td>9</td>
<td>31.0</td>
</tr>
<tr>
<td>5</td>
<td>29.8</td>
<td>10</td>
<td>30.5</td>
</tr>
</tbody>
</table>

```matlab
% Problem 6.12

clear
clc
disp('Problem 6.12: Scott Thomas')
format shortEng
time = 1:10;
p = [26.1 27.0 28.2 29.0 29.8 30.6 31.0 31.3 31.0 30.5];

% first-order equation
coeff1 = polyfit(time,p,1)
pfit1 = coeff1(1)*time + coeff1(2);
pplot1 = coeff1(1)*time + coeff1(2);

% second-order equation
coeff2 = polyfit(time,p,2)
pfit2 = coeff2(1)*time.^2 + coeff2(2)*time + coeff2(3);
pplot2 = coeff2(1)*time.^2 + coeff2(2)*time + coeff2(3);

% third-order equation
coeff3 = polyfit(time,p,3)
pfit3 = coeff3(1)*time.^3 + coeff3(2)*time.^2 + coeff3(3)*time + coeff3(4);
pplot3 = coeff3(1)*time.^3 + coeff3(2)*time.^2 + coeff3(3)*time + coeff3(4);

% Calculate the pressure at 11 seconds: Use the third-order equation.
t = 11;
p_11 = coeff3(1)*t_11^3 + coeff3(2)*t_11^2 + coeff3(3)*t_11 + coeff3(4)
figure
plot(time,p,'o',timep,pplot1, timep, pplot2, timep, pplot3,t, p_11,'r*')
xlabel('Time (sec)')
ylabel('Pressure P (psi)')
title('Problem 6.12: Scott Thomas')
legend('Original Data', 'First-Order', 'Second-Order', 'Third-Order', 'P(t = 11 sec)', 'Location', 'NorthWest')
```
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 6.12: Scott Thomas

Original Data
- First-Order
- Second-Order
- Third-Order
- P(t = 11 sec)

Pressure P (psi)

Time t (sec)

P = 0.54667t + 0.35333
P = -0.09773t^2 + 1.6217t - 1.7967
P = -0.00105672t^3 + 0.0766317t^2 + 0.8175019t - 0.890
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.

<table>
<thead>
<tr>
<th>$x$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>10</td>
<td>14</td>
<td>16</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>
% Problem 6.16
clear
clc
disp('Problem 6.16: Scott Thomas')
format shortEng
x = 1:10;
y = [10 14 16 18 19 20 21 22 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);
ypplot = 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')

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

Original Data

\[ y = 9.9123 + 5.7518 \ln(x) \]

\[ y(x = 2.5) = 15.1826 \]

\[ y(x = 11) = 23.7044 \]
Problem 6.15: Scott Thomas

\[ y = -0.0058473x^4 + 0.17104x^3 - 1.5867x^2 + 7.5233x + 3.9167 \]

**Graph:**
- Data 1
- 4th degree
- \( Y = f(X) \)

**Residuals:**
- 4th degree: norm of residuals = 0.39149