ME 1020 Engineering Programming with MATLAB

Chapter 7 Homework Solutions: 7.3, 7.6, 7.8, 7.10, 7.12, 7.14, 7.16, 7.23, 7.25

Problem 7.3:

3. The following list gives the measured breaking force in newtons for a sample of 60 pieces of certain type of cord. Plot the absolute frequency histogram. Try bin widths of 10, 30, and 50 N. Which gives the most meaningful histogram? Try to find a better value for the bin width.

311	138	340	199	270	255	332	279	231	296	198	269
257	236	313	281	288	225	216	250	259	323	280	205
279	159	276	354	278	221	192	281	204	361	321	282
254	273	334	172	240	327	261	282	208	213	299	318
356	269	355	232	275	234	267	240	331	222	370	226

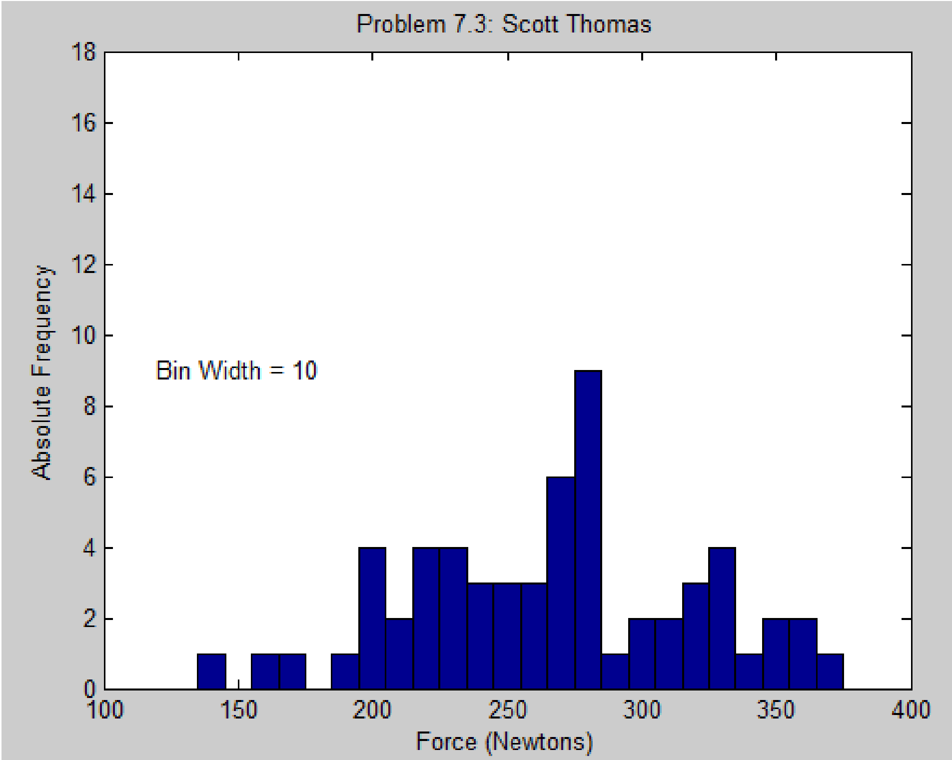
Go to the following webpage to download the data for this problem:

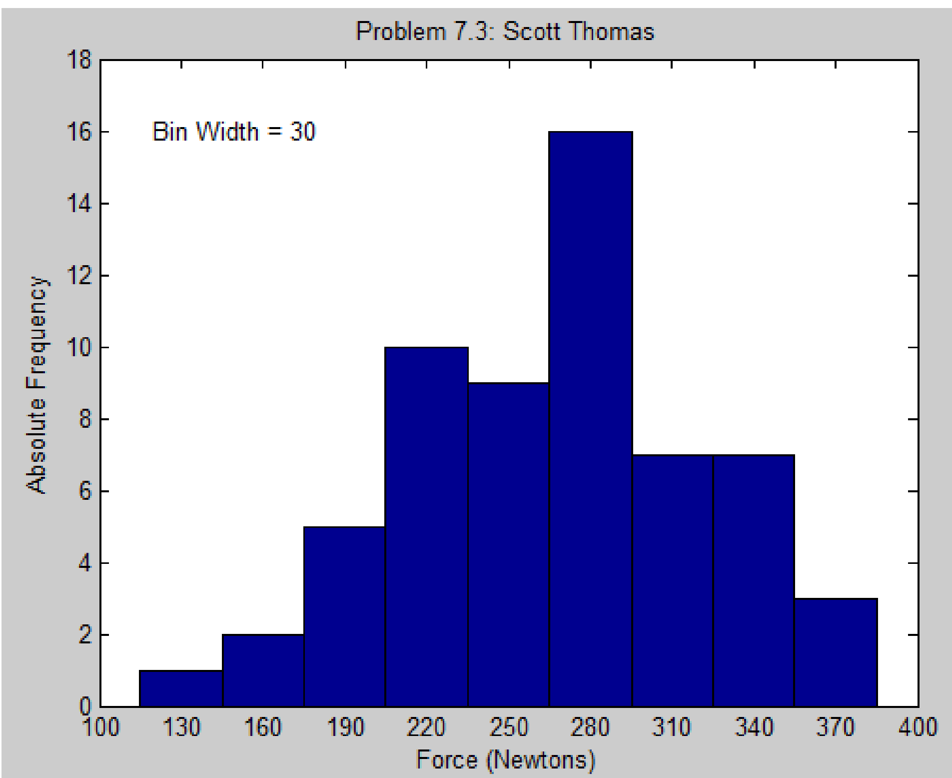
www.cs.wright.edu/~sthomas/prob7_3.xlsx

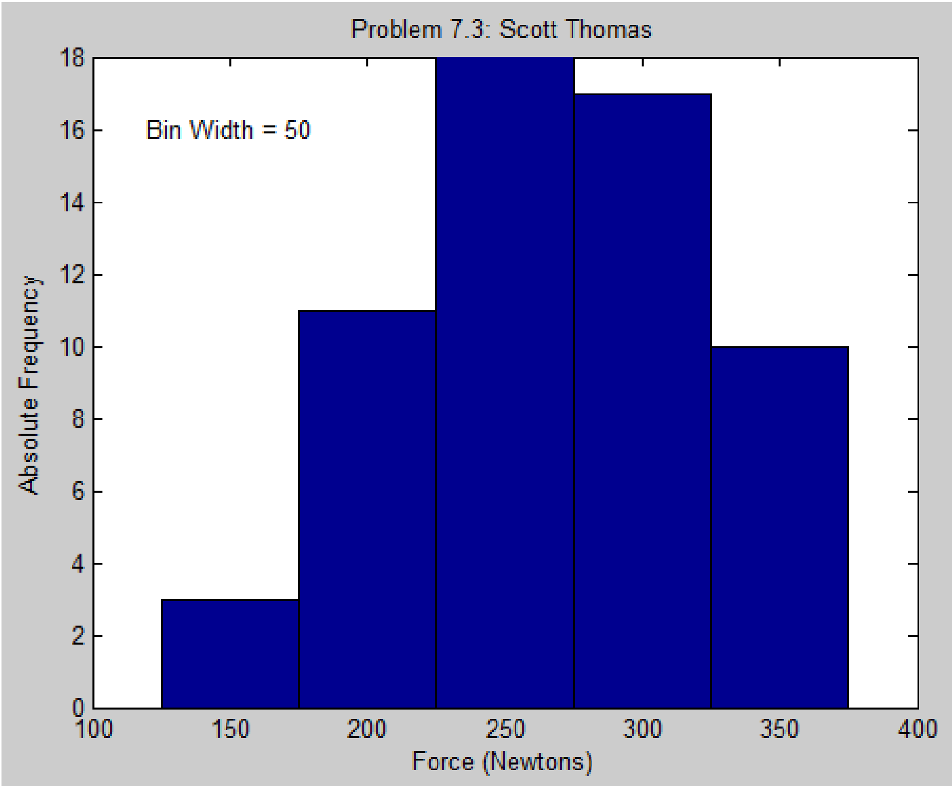
Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\problem7_3.m

problem7_3.m

```matlab
% Problem 7.3
clear
clc
disp('Problem 7.3: Scott Thomas')

force = xlsread('prob7_3');
start = 100;
stop = 400;
step1 = 10;
step2 = 30;
step3 = 50;
x1 = start:step1:stop;
x2 = start:step2:stop;
x3 = start:step3:stop;

%Absolute Frequency Plot:
figure
hist(force,x1)
xlabel('Force (Newtons)'), ylabel('Absolute Frequency')
title('Problem 7.3: Scott Thomas')
axis([start stop 0 18])
text(120, 9,'Bin Width = 10')

figure
hist(force,x2)
xlabel('Force (Newtons)'), ylabel('Absolute Frequency')
title('Problem 7.3: Scott Thomas')
axis([start stop 0 18])
text(120, 16,'Bin Width = 30')

figure
hist(force,x3)
xlabel('Force (Newtons)'), ylabel('Absolute Frequency')
title('Problem 7.3: Scott Thomas')
axis([start stop 0 18])
text(120, 16,'Bin Width = 50')
```


Problem 7.3: Scott Thomas
Bin Width = 10
Absolute Frequency
Force (Newtons)
0
2
4
6
8
10
12
14
16
18
100
150
200
250
300
350
400


Problem 7.3: Scott Thomas
Bin Width = 30
Absolute Frequency
Force (Newtons)
0
2
4
6
8
10
12
14
16
18
100
130
160
190
220
250
280
310
340
370
400


Problem 7.3: Scott Thomas
Bin Width = 50
Absolute Frequency
Force (Newtons)
0
2
4
6
8
10
12
14
16
18
100
150
200
250
300
350
400

Problem 7.6:

6. For the data given in Problem 3:

a. Plot the scaled frequency histogram.

b. Compute the mean and standard deviation, and use them to estimate the lower and upper limits of breaking force corresponding to 68 and 96 percent of cord pieces of this type. Compare these limits with those of the data.

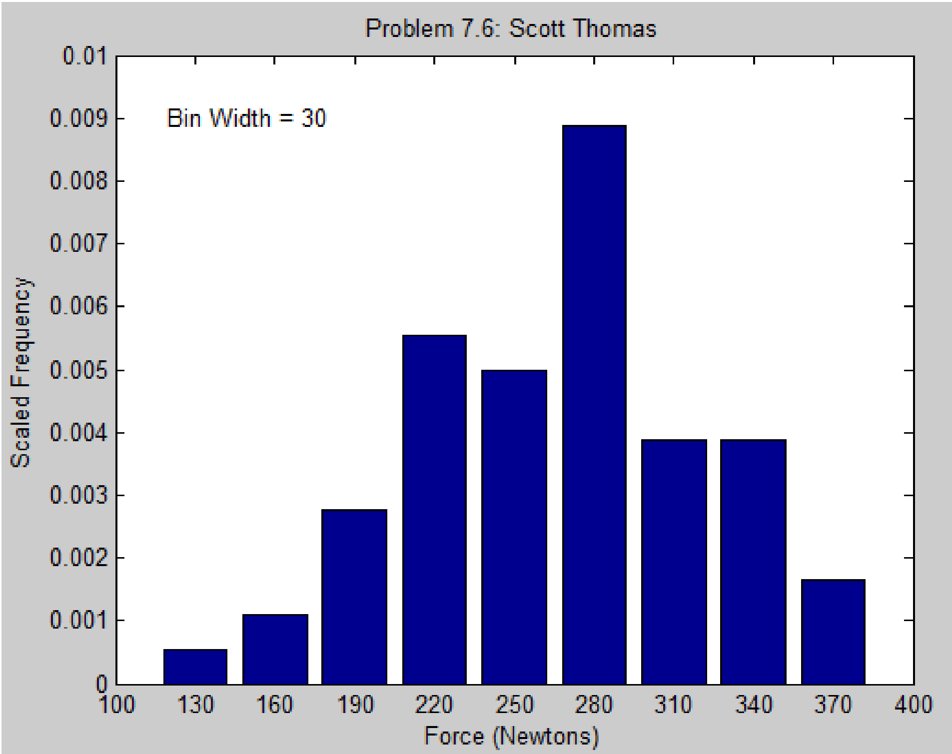
Go to the following webpage to download the data for this problem:

www.cs.wright.edu/~sthomas/prob7_3.xlsx

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\problem7_6.m

problem7_6.m

```
% Problem 7.6
clear
clc
disp('Problem 7.6: Scott Thomas')

force = xlsread('prob7_3');
binwidth = 30;
x = 100:binwidth:400;
[z,x] = hist(force,x); % z is the number of elements in each bin

% Compute scaled frequency data:
area = binwidth*length(force); % area of all bins = (binwidth)*(number of data points)
force_scaled = z/area;
% scaled frequency = (# of data points in each bin)/(total area of all of the bins)

% Plot the scaled histogram:
bar(x,force_scaled)
xlabel('Force (Newtons)'), ylabel('Scaled Frequency')
title('Problem 7.6: Scott Thomas')
axis([100,400,0,0.01])
text(120, 0.009,'Bin Width = 30')

% part b: Compute mean and standard deviation

mean_force = mean(force)
standard_dev_force = std(force)
force68percent = mean_force - standard_dev_force
force96percent = mean_force + 2*standard_dev_force
```



Command Window

```
Problem 7.6: Scott Thomas

mean_force =

   266.9500e+000


standard_dev_force =

    52.8212e+000


force68percent =

   214.1288e+000


force96percent =

   372.5925e+000
```

Problem 7.8:

8. Data from service records show that the time to repair a certain machine is normally distributed with a mean of 65 min and a standard deviation of 5 min. Estimate how often it will take more than 75 min to repair a machine.

Problem setup:

$$P(x \le b) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{b-\mu}{\sigma\sqrt{2}}\right)\right]$$

$$b = 75, \qquad \sigma = 5, \qquad \mu = 65$$

$$P(x \le 75) = \frac{1}{2}\left[1 + \mathrm{erf}\left(\frac{75-65}{5\sqrt{2}}\right)\right]$$

$$P(x > 75) = 1 - P(x \le 75)$$

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homewor

problem7_8.m*

```
% Problem 7.8
clear
clc
disp('Problem 7.8: Scott Thomas')
mu = 65;
b = 75;
sigma = 5;

P1 = 0.5*(1 + erf((b - mu)/(sigma*sqrt(2))))
P2= 1 - P1
```

Command Window

```
Problem 7.8: Scott Thomas

P1 =

   977.2499e-003


P2 =

    22.7501e-003
```

Problem 7.10:

10. A certain product requires that a shaft be inserted into a bearing. Measurements show that the diameter d_1 of the cylindrical hole in the bearing is normally distributed with a mean of 3 cm and a variance of 0.0064. The diameter d_2 of the shaft is normally distributed with a mean of 2.96 cm and a variance of 0.0036.

a. Compute the mean and the variance of the clearance $c = d_1 - d_2$.

b. Find the probability that a given shaft will not fit into the bearing. (*Hint:* Find the probability that the clearance is negative.)

Problem setup:

$$\mu_c = \mu_{d_1} - \mu_{d_2} = 3.00 - 2.96 = 0.04 \text{ cm}$$

$$\sigma_c^2 = \sigma_{d_1}^2 + \sigma_{d_2}^2 = 0.0064 + 0.0036 = 0.01 \text{ cm}^2$$

$$P(x \le b) = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{b-\mu}{\sigma\sqrt{2}}\right)\right]$$

$$b = 0, \qquad \sigma = \sqrt{0.01} = 0.1, \qquad \mu_c = 0.04 \text{ cm}$$

$$P(x \le 0) = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{0 - 0.04}{0.1\sqrt{2}}\right)\right]$$

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\pr

problem7_10.m

```
% Problem 7.10
clear
clc
disp('Problem 7.10: Scott Thomas')
mud1 = 3.00;
mud2 = 2.96;
muc = mud1 - mud2

variance_d1 = 0.0064;
variance_d2 = 0.0036;
variance_c = variance_d1 + variance_d2

b = 0.0;
sigma_c = sqrt(variance_c);

P3 = 0.5*(1 + erf((b - muc)/(sigma_c*sqrt(2))))

```

Command Window

```
Problem 7.10: Scott Thomas

muc =

    40.0000e-003


variance_c =

    10.0000e-003


P3 =

   344.5783e-003
```

Problem 7.12:

12. A certain product is assembled by placing three components end to end. The components' lengths are L_1, L_2, and L_3. Each component is manufactured on a different machine, so the random variations in their lengths are independent of one another. The lengths are normally distributed with means of 1, 2, and 1.5 ft and variances of 0.00014, 0.0002, and 0.0003, respectively.

a. Compute the mean and variance of the length of the assembled product.

b. Estimate the percentage of assembled products that will be no less than 4.48 and no more than 4.52 ft in length.

Problem setup:

$$\mu_{\text{pallet}} = \mu_{\text{part 1}} + \mu_{\text{part 2}} + \mu_{\text{part 3}} = 1.0 + 2.0 + 1.5 \text{ ft} = 4.5 \text{ ft}$$

$$\sigma^2_{\text{assembly}} = \sigma^2_{\text{part 1}} + \sigma^2_{\text{part 1}} + \sigma^2_{\text{part 3}} = 0.00014 + 0.0002 + 0.0003 \text{ ft} = 0.00064 \text{ ft}^2$$

$$P(a \le x \le b) = \frac{1}{2}\left[\operatorname{erf}\left(\frac{b-\mu}{\sigma\sqrt{2}}\right) + \operatorname{erf}\left(\frac{a-\mu}{\sigma\sqrt{2}}\right)\right]$$

$$a = 4.48 \text{ ft}, \qquad b = 4.52 \text{ ft}, \qquad \sigma = \sqrt{0.00064 \text{ ft}^2}, \qquad \mu = 4.5 \text{ ft}$$

$$P(4.48 \le x \le 4.52) = \frac{1}{2}\left[\operatorname{erf}\left(\frac{4.52-4.5}{\sqrt{0.00064}\sqrt{2}}\right) - \operatorname{erf}\left(\frac{4.48-4.5}{\sqrt{0.00064}\sqrt{2}}\right)\right]$$

EDIT | NAVIGATE | BREAKPOINTS | RUN

Backup ▸ matlab ▸ Homework Solutions ▸ Chapter 07 Homework ▸

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\problem7_12.m

problem7_12.m ×

```
% Problem 7.12
clear
clc
disp('Problem 7.12: Scott Thomas')
mu_parts = [1.0 2.0 1.5];
mu_assembly = sum(mu_parts)

variance_parts = [0.00014 0.0002 0.0003];
variance_assembly = sum(variance_parts)

sigma_assembly = sqrt(variance_assembly);
a = 4.48; b = 4.52;

P1 = 0.5*(erf((b - mu_assembly)/(sigma_assembly*sqrt(2)))...
    - erf((a - mu_assembly)/(sigma_assembly*sqrt(2))))

```

Command Window

```
Problem 7.12: Scott Thomas

mu_assembly =

     4.5000e+000


variance_assembly =

   640.0000e-006


P1 =

   570.8047e-003
```

Problem 7.14:

14. Use a random number generator to produce 1000 normally distributed numbers with a mean of 20 and a variance of 4. Obtain the mean, variance, and histogram of these numbers, and discuss whether they appear normally distributed with the desired mean and variance.

Problem setup: For normally distributed random numbers,

$$y = \sigma x + \mu$$

$$\mu = 20, \qquad \sigma^2 = 4, \qquad \sigma = 2$$

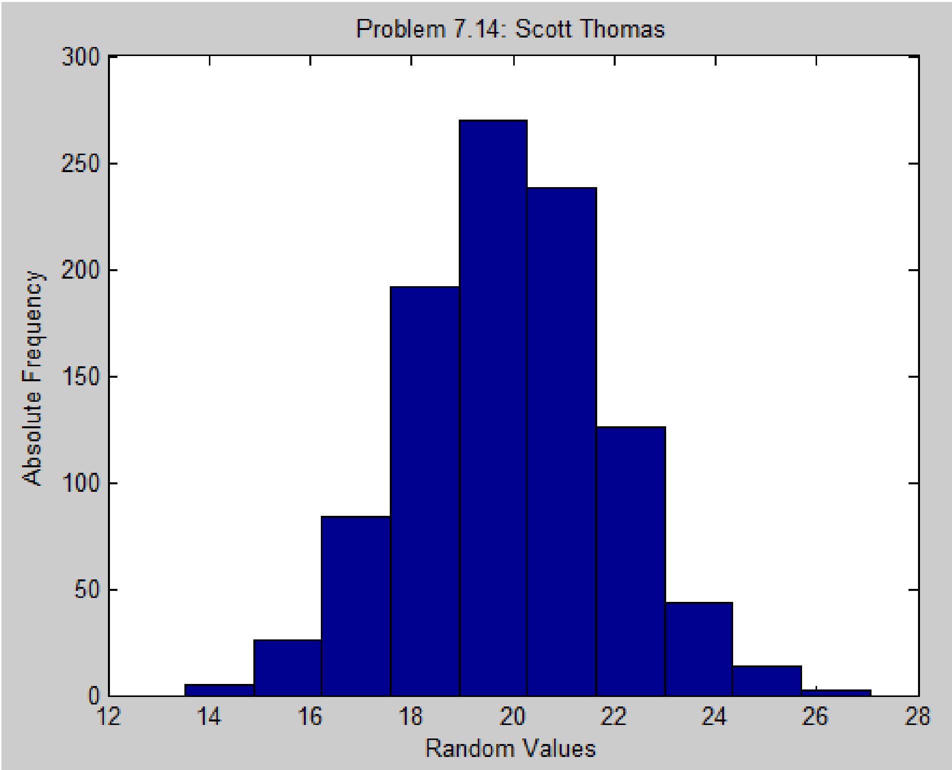
Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\problem7_14.m

problem7_14.m

```
% Problem 7.14
clear
clc
disp('Problem 7.14: Scott Thomas')

A = randn(1,1000);
mu = 20;
variance = 4;
sigma = sqrt(variance);
B = sigma*A + mu;

Bmean = mean(B)
Bvariance = var(B)
hist(B), xlabel('Random Values'), ylabel('Absolute Frequency')
title('Problem 7.14: Scott Thomas')
```

Command Window

```
Problem 7.14: Scott Thomas

Bmean =

    19.8995e+000


Bvariance =

     3.8682e+000
```


Problem 7.14: Scott Thomas
Absolute Frequency
Random Values
300
250
200
150
100
50
0
12
14
16
18
20
22
24
26
28

Problem 7.16:

16. Suppose that $z = xy$, where x and y are independent and normally distributed random variables. The mean and variance of x are $\mu_x = 10$ and $\sigma_x^2 = 2$. The mean and variance of y are $\mu_y = 15$ and $\sigma_y^2 = 3$. Find the mean and variance of z by simulation. Does $\mu_z = \mu_x \mu_y$? Does $\sigma_z^2 = \sigma_x^2 \sigma_y^2$? Do this for 100, 1000, and 5000 trials.

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chap

problem7_16.m

```
% Problem 7.16
clear
clc
disp('Problem 7.16: Scott Thomas')

mux = 10;
muy = 15;
variancex = 2;
variancey = 3;
sigmax = sqrt(variancex);
sigmay = sqrt(variancey);

x1 = sigmax*randn(1,100) + mux;
x2 = sigmax*randn(1,1000) + mux;
x3 = sigmax*randn(1,5000) + mux;

y1 = sigmay*randn(1,100) + muy;
y2 = sigmay*randn(1,1000) + muy;
y3 = sigmay*randn(1,5000) + muy;

z1 = x1.*y1;
z2 = x2.*y2;
z3 = x3.*y3;

z1mean = mean(z1)
z2mean = mean(z2)
z3mean = mean(z3)

z1variance = var(z1)
z2variance = var(z2)
z3variance = var(z3)

muz = mux*muy
variancez = variancex*variancey
```

Command Window

```
Problem 7.16: Scott Thomas

z1mean =

   149.1683e+000


z2mean =

   150.8382e+000


z3mean =

   149.9155e+000


z1variance =

   795.0412e+000


z2variance =

   753.2402e+000


z3variance =

   721.6498e+000


muz =

   150.0000e+000


variancez =

     6.0000e+000
```

Problem 7.23:

23. The following table gives temperature data in °C as a function of time of day and day of the week at a specific location. Data are missing for the entries marked with a question mark (?). Use linear interpolation with MATLAB to estimate the temperature at the missing points.

	Day				
Hour	**Mon**	**Tues**	**Wed**	**Thurs**	**Fri**
1	17	15	12	16	16
2	13	?	8	11	12
3	14	14	9	?	15
4	17	15	14	15	19
5	23	18	17	20	24

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\problem7_23.m

problem7_23.m

```
% Problem 7.23
clear
clc
disp('Problem 7.23: Scott Thomas')

timeTuesday = [1 3 4 5];
TemperatureTuesday = [15 14 15 18];

time_int = [2];
TempTuesday = interp1(timeTuesday,TemperatureTuesday,time_int)

timeThursday = [1 2 4 5];
TemperatureThursday = [16 11 15 20];

time_int = [3];
TempThursday = interp1(timeThursday,TemperatureThursday,time_int)
```

Command Window

```
Problem 7.23: Scott Thomas

TempTuesday =

   14.5000


TempThursday =

    13
```

Problem 7.25:

25. The following data are the measured temperature T of water flowing from a hot water faucet after it is turned on at time $t = 0$.

t (sec)	T (°F)	t (sec)	T (°F)
0	72.5	6	109.3
1	78.1	7	110.2
2	86.4	8	110.5
3	92.3	9	109.9
4	110.6	10	110.2
5	111.5		

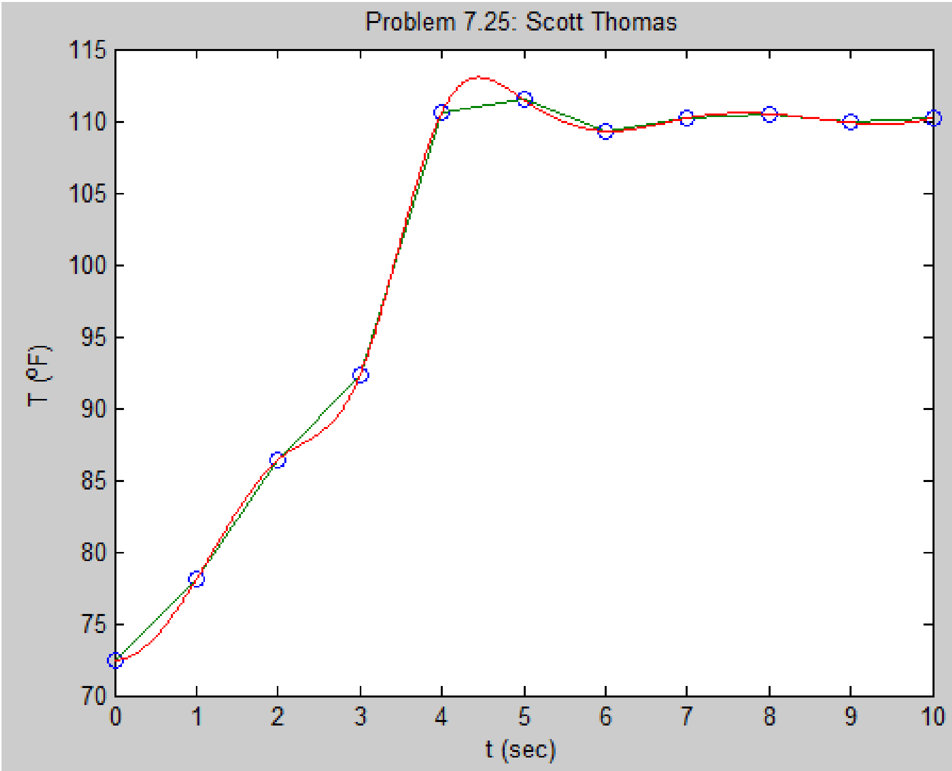
a. Plot the data with open circles, then plot the data by connecting them first with straight lines and then with a cubic spline.

b. Estimate the temperature values at the following times, using linear interpolation and then cubic spline interpolation: $t = 0.6, 2.5, 4.7, 8.9$.

Editor - C:\Laptop Backup\matlab\Homework Solutions\Chapter 07 Homework\problem7_25.m

problem7_25.m ×

```
% Problem 7.25
clear
clc
disp('Problem 7.25: Scott Thomas')

t = 0:10;
T = [72.5 78.1 86.4 92.3 110.6 111.5 109.3 110.2 110.5 109.9 110.2];

t_int = 0:0.01:10;
T_int = spline(t,T,t_int);

%Part a):
plot(t,T,'o',t,T, t_int, T_int),xlabel('t (sec)'), ylabel('T (^oF)')
title('Problem 7.25: Scott Thomas')

%Part b):
t_int = [0.6 2.5 4.7 8.9]
T_linear = interp1(t,T,t_int)
T_spline = spline(t,T,t_int)
```




```
Command Window
Problem 7.25: Scott Thomas

t_int =

    0.6000    2.5000    4.7000    8.9000


T_linear =

   75.8600   89.3500  111.2300  109.9600


T_spline =

   74.7235   88.2044  112.6234  109.9533
```