Chapter 4
Solved Problems

Problem 1

Script file:

```
T=input('Enter the temperature (degrees F)  ');
v=input('Enter the wind speed (mi/h)  ');
Twc=round(35.74+0.6215*T-35.75*v^0.16+0.4275*T*v^0.16);
fprintf('The wind chill temperature is:%5.0f F\n',Twc)
```

Command Window:

```
Enter the temperature (degrees F)  30
Enter the wind speed (mi/h)  42
The wind chill temperature is:   13 F
```

Problem 2

Script file:

```
clear, clc
format bank
P=100000; r=0.0485;
y=10:30;

M=P*(r/12)./(1-(1+r/12).^(-12*y));
T=M*12.*y;
Table=[y' M' T'];
disp('         Years      Monthly Pay  Total Pay')
disp(Table)
```

Command Window:

```
         Years      Monthly Pay  Total Pay
         10.00       1053.34     126400.61
         11.00        979.04     129232.91
         12.00        917.38     132103.25
         13.00        865.46     135011.41
         14.00        821.17     137957.19
         15.00        783.00     140940.34
         16.00        749.79     143960.61
         17.00        720.68     147017.75
         18.00        694.96     150111.46
         19.00        672.11     153241.46
         20.00        651.70     156407.43
         21.00        633.37     159609.05
         22.00        616.84     162846.00
         23.00        601.88     166117.91
         24.00        588.28     169424.44
         25.00        575.88     172765.22
         26.00        564.55     176139.85
         27.00        554.16     179547.96
         28.00        544.61     182989.14
         29.00        535.81     186462.98
         30.00        527.69     189969.06
```

Problem 3

Script file:

```
clear,clc
V=8000;
k=[0.2 0.3 0.4 0.6 0.7];
b= (4*V./(pi^2*(k+1).*(1-k).^2)).^(1/3);
a=k.*b;
S=pi^2*(b.^2-a.^2);
Table=[a' b' S'];
disp('         a (in)         b (in)       S (in^2)')
disp(Table
```

Command Window:

```
         a (in)         b (in)       S (in^2)
          3.23         16.16       2474.93
          5.16         17.20       2657.55
          7.44         18.60       2867.65
         13.99         23.31       3432.05
         19.37         27.67       3854.57
```

Problem 4

Script file:

```
clear,clc
h=8:2:16; V=1000; k=1.20;
R1=sqrt(3*V/pi/(1+k^2+k)./h);
R2=k*R1;
S=pi*(R1+R2).*sqrt((R2-R1).^2+h.^2)+pi*(R1.^2+R2.^2);
Table=[h' R1' R2' S'];
disp(' ')
disp('          h(cm)          R1(cm)          R2(cm)
S(cm^2)')
disp(' ')
disp(Table)
```

Command Window:

```
    h(cm)          R1(cm)          R2(cm)        S(cm^2)

     8.00            5.73            6.87         571.23
    10.00            5.12            6.15         556.95
    12.00            4.68            5.61         556.55
    14.00            4.33            5.19         563.30
    16.00            4.05            4.86         574.04
```

Problem 5

Script file:

```
clear,clc
g=input('Enter the grades as elements in a vector  ');
gN=length(g);
gave=mean(g);
gstd=std(g);
gmed=median(g);
fprintf('There are %3.0f grades.\n',gN)
fprintf('The average grade is %5.2f.\n',gave)
fprintf('The standard deviation is %5.2f.\n',gstd)
fprintf('The median grade is %5.2f.\n',gmed)
```

Command Window:

```
Enter the grades as elements in a vector  [81 65 61 78 94 80
65 76 77 95 82 49 75]
There are  13 grades.
The average grade is 75.23.
The standard deviation is 12.77.
The median grade is 77.00.
```

Problem 6

Script file:

```
clear, clc
k = log(2);
t=0:24;
N=exp(k*t);
Table=[t' N'];
disp(' ')
disp('        Time(hrs)    No of Bacteria')
disp(Table)
```

Command Window:

```
        Time(hrs)    No of Bacteria
            0             1
            1             2
            2             4
            3             8
            4            16
            5            32
            6            64
            7           128
            8           256
            9           512
           10          1024
           11          2048
           12          4096
           13          8192
           14         16384
           15         32768
           16         65536
           17   1.3107e+005
           18   2.6214e+005
           19   5.2429e+005
           20   1.0486e+006
           21   2.0972e+006
           22   4.1943e+006
           23   8.3886e+006
           24   1.6777e+007
```

Problem 7

Script file:

```
h=4000:4000:40000;
alm=[2.0 2.9 3.5 4.1 4.5 5.0 5.4 5.7 6.1 6.4];
thm=90-alm;
Rm=h.*sind(thm)./(1-sind(thm))
RmA=mean(Rm)
```

Command Window:

```
Rm =
  6.5623e+006  6.2389e+006  6.4216e+006  6.2359e+006
6.4679e+006   6.283e+006  6.2811e+006  6.4399e+006
6.3221e+006  6.3784e+006
RmA =
  6.3631e+006
```

Problem 8

Script file:

```
clear, clc
t=0:0.02:0.5;
x=4.214*(exp(-1.58*t)-exp(-6.32*t));
v=26.67*exp(-6.32*t)-6.67*exp(-1.58*t);
Table=[t' x' v'];
disp(' ')
disp('        Time(s)       x (m)        v (m/s)')
disp(Table)
```

Command Window:

```
        Time(s)       x (m)        v (m/s)
             0            0           20
          0.02      0.36928        17.041
          0.04      0.68323        14.451
          0.06      0.94877        12.186
          0.08        1.172        10.208
           0.1       1.3583        8.4807
          0.12       1.5123        6.9746
          0.14       1.6382        5.6629
          0.16       1.7397         4.522
          0.18       1.8199        3.5311
           0.2       1.8817         2.672
          0.22       1.9275        1.9286
          0.24       1.9595        1.2867
          0.26       1.9796       0.73391
          0.28       1.9894       0.25917
           0.3       1.9904      -0.14714
          0.32        1.984      -0.49353
          0.34       1.9711      -0.78747
          0.36       1.9529       -1.0355
          0.38       1.9301       -1.2435
           0.4       1.9035       -1.4165
          0.42       1.8738        -1.559
          0.44       1.8415       -1.6749
          0.46       1.8071       -1.7677
          0.48        1.771       -1.8404
           0.5       1.7337       -1.8957
```

Problem 9

Script file:

```
clear,clc
k = log(1/2)/13.3
t=0:4:48;
Relative_amount=exp(k*t);
Table=[t' Relative_amount'];
disp(' ')
disp('         time(hrs)    A/A0')
disp(Table)
```

Command Window:

```
k =
    -0.052116

         time(hrs)    A/A0
            0            1
            4      0.81183
            8      0.65907
           12      0.53505
           16      0.43437
           20      0.35263
           24      0.28628
           28      0.23241
           32      0.18868
           36      0.15317
           40      0.12435
           44      0.10095
           48     0.081955
```

Problem 10

Script file:

```
clear, clc
format bank
A=10000; n=10;
r=2:0.5:6;
B=A*(1+r/100).^n;
Table=[r' B'];
disp(' ')
disp('     Interest Rate  Acc Value')
disp(Table)
```

Command Window:

```
     Interest Rate  Acc Value
          2.00      12189.94
          2.50      12800.85
          3.00      13439.16
          3.50      14105.99
          4.00      14802.44
          4.50      15529.69
          5.00      16288.95
          5.50      17081.44
          6.00      17908.48
```

Problem 11

Script file:

```
clear,clc
a=5:0.05:20;
b=60./(a-3.5)+2.4;
Apage=a.*b;
[Apagem,ele]=min(Apage);
aPage=a(ele)
bPage=b(ele)
ApageSmallest=Apagem
```

Command Window:

```
aPage =
        12.85
bPage =
       8.8171
ApageSmallest =
        113.3
```

Problem 12

Script file:

```
clear, clc
R=55;
a=5:0.25:100;
b=2*sqrt(R^2-(a/2).^2);
A=(a-8).*(b-20);
[Am n]=max(A);
aMax=a(n)
bMax=b(n)
PictureArea=Am
```

Command Window:

```
aMax =
         74.5
bMax =
       80.931
PictureArea =
       4051.9
```

Problem 13

Script file:

```
clear, clc
A=20000; r=6.5; t=60;
n=6:6:60;
rc=r/1200;
P=391.32;
B=A*(1+rc).^n-(P/rc)*((1+rc).^n-1);
PerPaid=(A-B)./A*100;
Table=[n' B' PerPaid'];
disp('         Month      Balance    Percent Paid')
disp(Table)
```

Command Window:

```
         Month      Balance    Percent Paid
            6        18279       8.6054
           12        16501       17.494
           18        14665       26.676
           24        12768        36.16
           30        10809       45.957
           36       8784.8       56.076
           42       6694.2       66.529
           48       4534.8       77.326
           54       2304.2       88.479
           60       0.2095       99.999
```

Problem 14

Script file:

```
clear, clc
H=50; h=130;
x=30:0.5:300;
AB=sqrt(x.^2+h^2);
AC=sqrt(x.^2+(h+H)^2);
th=acosd((AB.^2+AC.^2-H^2)./(2*AB.*AC));
[thMax n]=max(th);
xthMax=x(n)
thMax
```

Command Window:

```
xthMax =
   153
thMax =
       9.2818
```

Problem 15

Script file:

```
L = 48; ds = 30; dw = 40;
vswim = 1; vrun = 3;
y = 20:1:48;
ls = sqrt(y.^2+ds^2);
lw = sqrt((L-y).^2+dw^2);
t = ls/vrun + lw/vswim;
[tmin i] = min(t)
y_ = y(i)
phi_ = atan(y_/ds);
alpha_ = atan((L-y_)/dw);
sin_ratio=sin(phi_)/sin(alpha_)
speed_ratio=vrun/vswim
```

Command Window:

```
tmin =
   57.3629
i =
    18
y_ =
    37
sin_ratio =
    2.9294
speed_ratio =
     3
```

Answer: The minimum time is 57.36 seconds with the lifeguard entering the water at y = 37 m. Snell's law seems only approximately satisfied but this is due to the rough increment size of 1m. For example, decreasing the increment to 0.1 m gives a sin ratio of 2.9862, very close to 3.

Problem 16

Script file:

```
clear, clc
v=50; rho=2000; h=500;
tmax=pi/2*rho/v;
t=linspace(0,tmax,15);
al=v*t/rho;
H=h+rho*(1-cos(al));
X=rho*sin(al);
r=sqrt(H.^2+X.^2);
th=acosd(X./r);
Table=[t' th' r'];
disp('         t(s)        th (deg)        r(m)')
disp(Table)
```

Command Window:

```
         t(s)        th (deg)        r(m)
            0              90         500
        4.488         66.401        559.35
        8.976         51.029        707.62
       13.464         42.826        900.65
       17.952         38.814        1113.7
        22.44         37.162        1335.2
       26.928         36.902        1559.4
       31.416         37.516          1783
       35.904         38.706        2003.8
       40.392         40.296        2220.3
        44.88         42.171        2431.3
       49.368         44.257        2635.8
       53.856         46.503        2832.8
       58.344         48.873        3021.6
       62.832          51.34        3201.6
```

Problem 17

Script file:

```
clear, clc
h=-500:500:10000;
p=29.921*(1-6.8753E-6*h);
T=49.161*log(p)+44.932;
Table=[h' T'];
disp('         h(ft)        T(F)')
disp(Table)
```

Command Window:

```
         h(ft)        T(F)
         -500       212.18
            0       212.01
          500       211.84
         1000       211.67
         1500        211.5
         2000       211.33
         2500       211.16
         3000       210.98
         3500       210.81
         4000       210.64
         4500       210.46
         5000       210.29
         5500       210.11
         6000       209.94
         6500       209.76
         7000       209.58
         7500       209.41
         8000       209.23
         8500       209.05
         9000       208.87
         9500       208.69
        10000       208.51
```

Problem 18

Script file:

```
clear,clc
a=34172;
b=7.9622;
T=0:2:42;
Logp=b-0.05223*a./(T+273);
p=10.^Logp;
table=[T' p'];
disp(' ')
disp('          T (C)      p(mmHg)')
disp(' ')
disp(table)
```

Command Window:

```
          T (C)      p(mmHg)

            0        26.574
            2        29.649
            4        33.027
            6        36.733
            8        40.793
           10        45.235
           12        50.088
           14        55.382
           16        61.152
           18         67.43
           20        74.254
           22        81.662
           24        89.693
           26        98.391
           28         107.8
           30        117.97
           32        128.94
           34        140.77
           36        153.51
           38        167.22
           40        181.95
           42        197.77
```

Problem 19

Script file:

```
clear, clc
T=200:20:400;
CpSO2=38.91+3.904E-2*T-3.105E-5*T.^2+8.606E-9*T.^3;
CpSO3=48.5+9.188E-2*T-8.54E-5*T.^2+32.4E-9*T.^3;
CpO2=29.1+1.158E-2*T-0.6076E-5*T.^2+1.311E-9*T.^3;
CpN2=29.0+0.2199E-2*T-0.5723E-5*T.^2-2.871E-9*T.^3;
Table=[T',CpSO2',CpSO3',CpO2',CpN2'];
disp(' ')
disp('Heat Capacity in Joules/(g mol)(C)')
disp('Temperature in degrees C')
disp(' ')
disp('     Temperature    SO2         SO3          O2
N2')
disp(Table)
```

Command Window:

```
Heat Capacity in Joules/(g mol)(C)
Temperature in degrees C

   Temperature     SO2          SO3           O2           N2
        200       45.545       63.719       31.183       29.188
        220       46.088       64.925       31.367       29.176
        240        46.61        66.08       31.547       29.158
        260       47.113       67.185       31.723       29.134
        280       47.596       68.242       31.895       29.104
        300        48.06       69.253       32.063       29.067
        320       48.505       70.218       32.226       29.024
        340       48.932        71.14       32.386       28.973
        360       49.342       72.021       32.543       28.916
        380       49.734        72.86       32.695       28.852
        400       50.109       73.662       32.844        28.78
```

Problem 20

Script file:

```
T=[25 150 300];
CpSO2=38.91+3.904E-2*T-3.105E-5*T.^2+8.606E-9*T.^3;
CpSO3=48.5+9.188E-2*T-8.54E-5*T.^2+32.4E-9*T.^3;
CpO2=29.1+1.158E-2*T-0.6076E-5*T.^2+1.311E-9*T.^3;
CpN2=29.0+0.2199E-2*T-0.5723E-5*T.^2-2.871E-9*T.^3;
% Each column of the A matrix has the heat capacities
% for one of the gasses
A=[CpSO2',CpSO3',CpO2',CpN2'];
A(4,:)=[1 1 1 1]
B=[39.82;  44.72;  49.10;  1];
A\B
```

Command Window:

```
A =
   39.8667   50.7441   29.3857   29.0514
   44.0964   60.4698   30.7047   29.1914
   48.0599   69.2528   32.0626   29.0671
    1.0000    1.0000    1.0000    1.0000
ans =
    0.1477
    0.4212
    0.1002
    0.3308
```

Answer: Fractions of SO2, SO3, O2 and N2 are 0.1477, 0.4212, 0.1002, and 0.3308 respectively.

Problem 21

Script File:

```
vs=input('Please enter the source voltage  ');
Rn=input('Enter the value of the resistors as elements in a
row vector\n');
in=vs./Rn;
Pn=vs*in;
Req=1/sum(1./Rn);
is=vs/Req;
Ptotal=vs*is;
Table=[Rn', in', Pn'];
disp(' ')
disp(' Resistance   Current   Power')
disp('   (Ohms)     (Amps)   (Watts)')
disp(' ')
disp(Table)
disp(' ')
fprintf('The source current circuit is %f Amps.',is)
fprintf('\nThe total power dissipated in the circuit is %f
Watts.\n',Ptotal)
```

Command Window:

```
Please enter the source voltage  48
Enter the value of the resistors as elements in a row vector
[20 34 26 45 60 10]

 Resistance   Current   Power
   (Ohms)     (Amps)   (Watts)

   20.0000    2.4000  115.2000
   34.0000    1.4118   67.7647
   26.0000    1.8462   88.6154
   45.0000    1.0667   51.2000
   60.0000    0.8000   38.4000
   10.0000    4.8000  230.4000

The source current circuit is 12.324585 Amps.
The total power dissipated in the circuit is 591.580090
Watts.
```

Problem 22

Script file:

```
clear, clc
A=sind(45); B=cosd(45);
C=sind(48.81); D=cosd(48.81);
a=[-B 0 0 1 0 0 0 0 0
-A 0 -1 0 0 0 0 0 0
0 -1 0 0 A 1 0 0 0
0 0 0 -1 -D 0 0 1 0
0 0 0 0 -C 0 -1 0 0
0 0 0 0 0 0 0 0 -C
0 0 0 0 0 0 0 -1 -D
0 0 0 0 0 0 1 0 C
0 0 0 0 0 -1 0 0 D];
b=[0; 0; 0; 0; 600; 1800; 0; 4800; 0];
F=a\b;
Table=[[1:9]' F];
disp('         Member    Force (lb)')
disp(Table)
```

Command Window:

```
         Member    Force (lb)
            1         11139
            2        -8340.6
            3        -7876.1
            4         7876.1
            5        -9567.7
            6        -1575.2
            7           6600
            8         1575.2
            9        -2391.9
```

Problem 23

Script file:

```
clear, clc
A=1/2; B=sqrt(3)/2;

a=[A 1 0 0 0 0 0 0 0 0
B 0 0 0 0 0 0 0 0 0
-A 0 A 1 0 0 0 0 0 0
-B 0 -B 0 0 0 0 0 0 0
0 -1 -A 0 A 1 0 0 0 0
0 0 B 0 B 0 0 0 0 0
0 0 0 -1 -A 0 A 1 0 0
0 0 0 0 -B 0 -B 0 0 0
0 0 0 0 0 -1 -A 0 A 1
0 0 0 0 0 0 B 0 B 0
0 0 0 0 0 0 0 -1 -A 0 A];
b=[0; -6; 0; 0; 0; 5; 0; 0; 0; 8; 0];
F=a\b;
Table=[[1:11]' F];
disp('         Member    Force (kN)')
disp(Table)
```

Command Window:

```
         Member    Force (kN)
            1      -6.9282
            2       3.4641
            3       6.9282
            4      -6.9282
            5      -1.1547
            6       7.5056
            7       1.1547
            8      -8.0829
            9       8.0829
           10       4.0415
           11      -8.0829
```

Problem 24

Script file:

```
clear, clc
A=[(-4)^4 (-4)^3 (-4)^2 -4 1
   (-2)^4 (-2)^3 (-2)^2 -2 1
   .2^4 .2^3 .2^2 .2 1
   1^4 1^3 1^2 1 1
   4^4 4^3 4^2 4 1];
B=[-7.6;-17.2;9.2;-1.6;-36.4];
coefficients = A\B
```

Command Window:

```
coefficients =
          0.5
         -0.1
          -10
           -2
           10
```

Problem 25

Script file:

```
clear, clc
t=0.2; c=1;
K=t*c/0.2;
x=[0.15 0.35 0.5 0.7 0.85];

A=[sqrt(x(1)/c) x(1)/c (x(1)/c)^2 (x(1)/c)^3 (x(1)/c)^4
    sqrt(x(2)/c) x(2)/c (x(2)/c)^2 (x(2)/c)^3 (x(2)/c)^4
    sqrt(x(3)/c) x(3)/c (x(3)/c)^2 (x(3)/c)^3 (x(3)/c)^4
    sqrt(x(4)/c) x(4)/c (x(4)/c)^2 (x(4)/c)^3 (x(4)/c)^4
    sqrt(x(5)/c) x(5)/c (x(5)/c)^2 (x(5)/c)^3 (x(5)/c)^4];
y=[0.08909; 0.09914; 0.08823; 0.06107; 0.03421]./K;
coefficients = A\y
```

Command Window:

```
coefficients =
      0.29688
     -0.12581
     -0.35257
      0.28606
     -0.10251
```

Problem 26

Script file:

```
clear, clc
A=[1 2 1 1
2 3 0 1
1 4 1 0
1 3 2 0];
B=[5; 12; 11; 8];
Points=A\B
```

Command Window:

```
Points =
             4
             2
            -1
            -2
```

Problem 27

In matrix form, the system of equations is:

$$\begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & -1 & 0 \\ 0 & 3 & 0 & 0 & -4 & -1 & -1 \\ 0 & 0 & 1 & 0 & 0 & 0 & -2 \\ 0 & -1 & 1 & -2 & 2 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \\ d \\ e \\ f \\ g \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ Value\ for\ a \end{bmatrix}$$

Script file:

```
A=[1 0 0 -1 0 0 0
   1 0 0 0 -1 0 0
   0 1 0 0 0 -1 0
   0 3 0 0 -4 -1 -1
   0 0 1 0 0 0 -2
   0 -1 1 -2 2 0 0
   1 0 0 0 0 0 0]
```

```
B=[0; 0; 0; 0; 0; 0; 1] % guessing a=1
Solution1=A\B
B=[0; 0; 0; 0; 0; 0; 2] % guessing a=2
Solution2=A\B
B=[0; 0; 0; 0; 0; 0; 3] % guessing a=3
Solution3=A\B
```

Command Window:

```
A =
     1     0     0    -1     0     0     0
     1     0     0     0    -1     0     0
     0     1     0     0     0    -1     0
     0     3     0     0    -4    -1    -1
     0     0     1     0     0     0    -2
     0    -1     1    -2     2     0     0
     1     0     0     0     0     0     0
B =
     0
     0
     0
     0
     0
     0
     1
Solution1 =
    1.0000
    2.6667
    2.6667
    1.0000
    1.0000
    2.6667
    1.3333
B =
     0
     0
     0
     0
     0
     0
     2
Solution2 =
    2.0000
    5.3333
    5.3333
    2.0000
```

```
    2.0000
    5.3333
    2.6667
B =
     0
     0
     0
     0
     0
     0
     3
Solution3 =
    3.0000
    8.0000
    8.0000
    3.0000
    3.0000
    8.0000
    4.0000
```

Answer: a = 3, b = 8, c = 8, d = 3, e = 3, f = 8, g = 4

Problem 28

Script file:

```
clear, clc
Ts=40:-10:-40;
T=[Ts;Ts;Ts;Ts;Ts;Ts];
vs=[10:10:60]';
v=[vs vs vs vs vs vs vs vs vs];
Twc=round(35.74+0.6215*T-35.75*v.^0.16+0.4275*T.*v.^0.16);
disp('                          Temperature (F)')
fprintf('      ')
fprintf('   %3.0f',Ts)
fprintf('\n  Speed\n  (mi/h)\n')
Table=[vs Twc];
%fprintf(' %3.0f\n',Table)
disp(Table)
```

Command Window:

```
                        Temperature (F)
         40    30    20    10     0   -10   -20   -30   -40
  Speed
  (mi/h)
    10    34    21     9    -4   -16   -28   -41   -53   -66
    20    30    17     4    -9   -22   -35   -48   -61   -74
    30    28    15     1   -12   -26   -39   -53   -67   -80
    40    27    13    -1   -15   -29   -43   -57   -71   -84
    50    26    12    -3   -17   -31   -45   -60   -74   -88
    60    25    10    -4   -19   -33   -48   -62   -76   -91
```

Problem 29

Script file:

```
clear, clc
alp=0.05:0.05:0.95;
K=pi*alp/2;
CI=sqrt(2*tan(K)./(pi*alp)).*(0.923+0.199*(1-sin(K))./
cos(K);
Table=[alp' CI'];
disp('    Alpha       CI')
disp(Table)
```

Command Window:

```
    Alpha       CI
    0.0500    1.1110
    0.1000    1.1090
    0.1500    1.1165
    0.2000    1.1340
    0.2500    1.1626
    0.3000    1.2040
    0.3500    1.2605
    0.4000    1.3359
    0.4500    1.4351
    0.5000    1.5659
    0.5500    1.7400
    0.6000    1.9758
    0.6500    2.3042
    0.7000    2.7800
    0.7500    3.5094
    0.8000    4.7237
    0.8500    7.0251
    0.9000   12.5021
    0.9500   34.3505
```