Chapter 4
Solved Problems

Problem 1

Script file:

```
clear, clc
T=input('Please enter the temperature in deg F: ');
R=input('Please enter the relative humidity in percent: ');
HI=-42.379+2.04901523*T+10.14333127*R-0.22475541*T*R-6.83783e-3*T^2 ...
    - 5.481717e-2*R^2+1.22874e-3*T^2*R + 8.5282e-4*T*R^2-1.99e-6*T^2*R^2;
fprintf('\nThe Heat Index Temperature is: %.0f\n',HI)
```

Command Window:

```
Please enter the temperature in deg F: 90
Please enter the relative humidity in percent: 90

The Heat Index Temperature is: 122
```

Problem 2

Script file:

```
clear, clc
format bank
F=100000; r=4.35; years=5:10;
%convert percent to decimal
r=r/100;
monthly_deposit=F*(r/12)./((1+r/12).^(12*years)-1);
tbl=[years' monthly_deposit'];
disp('                    Monthly')
disp('         Years      Deposit')
disp(tbl)
```

Command Window:

```
                  Monthly
         Years    Deposit
          5.00    1494.99
          6.00    1218.02
          7.00    1020.55
          8.00     872.78
          9.00     758.13
         10.00     666.67
```

Problem 3

Script file:

```
clear, clc
%40 minutes is 2/3 hour
format short g
k=1.5*log(2);
t=2:2:24;
Number_of_bactera=exp(k*t)
```

Command Window:

```
Number_of_bactera =
  Columns 1 through 5
           8          64         512        4096       32768
  Columns 6 through 10
   2.6214e+05   2.0972e+06   1.6777e+07   1.3422e+08   1.0737e+09
  Columns 11 through 12
   8.5899e+09   6.8719e+10
```

Problem 4

Script file:

```
clear, clc
format short g
r2=12:4:28;
r1=0.7*r2;
S=pi^2*(r2.^2-r1.^2);
V=1/4*pi^2*(r1+r2).*(r2-r1).^2;
tbl=[r2' r1' V' S'];
disp('         Outer        Inner                  Surface')
disp('         Radius       Radius     Volume       Area')
disp('          (in)         (in)      (in^3)       (in^2)')
disp(tbl)
```

Command Window:

```
         Outer        Inner                  Surface
         Radius       Radius     Volume       Area
          (in)         (in)      (in^3)       (in^2)
           12          8.4       652.34       724.82
           16         11.2       1546.3       1288.6
           20           14       3020.1       2013.4
           24         16.8       5218.7       2899.3
           28         19.6       8287.2       3946.3
```

Problem 5

Script file:

```
clear, clc
format short g
W=500; L=120; h=50;
x=10:20:110;
Tension=W*L*sqrt(h^2+x.^2)./(h*x)
```

Command Window:

```
Tension =
  Columns 1 through 5
       6118.8       2332.4       1697.1       1474.7       1372.8
  Column 6
       1318.2
```

Problem 6

Script file:

```
clear, clc
grades=input('Please enter the grades as a vector [x x x]: ');
number=length(grades);
aver=mean(grades);
standard_dev=std(grades);
middle=median(grades);
fprintf('\nThere are %i grades.\n',number)
fprintf('The average grade is %.1f.\n',aver)
fprintf('The standard deviation is %.1f.\n',standard_dev)
fprintf('The median grade is %.1f.\n',middle)
```

Command Window:

```
Please enter the grades as a vector [x x x]: [92 74 53 61 100 42 80 66 71 78
91 85 79 68]

There are 14 grades.
The average grade is 74.3.
The standard deviation is 15.8.
The median grade is 76.0.
```

Problem 7

Script file:

```
clear, clc
format short g
h=4:4:40;  theta=[2 2.9 3.5 4.1 4.5 5 5.4 5.7 6.1 6.4];
R=h.*cosd(theta)./(1-cosd(theta));
average=mean(R);
disp('The average estimated radius of the earth in km is:')
disp(average)
```

Command Window:

```
The average estimated radius of the earth in km is:
       6363.1
```

Problem 8

Script file:

```
clear, clc
k=log(0.5)/13.3;
t=0:4:48;
ratio=exp(k*t)
```

Command Window:

```
ratio =
  Columns 1 through 7
    1.0000    0.8118    0.6591    0.5350    0.4344    0.3526    0.2863
  Columns 8 through 13
    0.2324    0.1887    0.1532    0.1244    0.1010    0.0820
```

Problem 9

Script file:

```
clear, clc
L=input('Please enter the mortgage amount: ');
N=input('Please enter the number of years: ');
r=input('Please enter the interest rate in percent: ');
P=L*(r/1200)*(1+r/1200)^(12*N)/((1+r/1200)^(12*N)-1);
fprintf('\nThe monthly payment of a %i years %.2f mortgage\n',N,L)
fprintf('with interest rate of %.2f percent is $%.2f\n',r,P)
```

Command Window:

```
Please enter the mortgage amount: 250000
Please enter the number of years: 30
Please enter the interest rate in percent: 4.5

The monthly payment of a 30 years 250000.00 mortgage
with interest rate of 4.50 percent is $1266.71
```

Problem 10

Script file:

```
clear, clc
format bank
A=20000; r=6.5; P=391.32; month=6:6:60;
B=A*(1+r/1200).^month-P*1200/r*((1+r/1200).^month-1);
perc=100*B/A;
tbl=[month' B' perc'];
disp('                    Balance        Remaining')
disp('         Month         $              %')
disp(tbl)
```

Command Window:

```
                    Balance        Remaining
         Month         $              %
          6.00      18278.92         91.39
         12.00      16501.14         82.51
         18.00      14664.80         73.32
         24.00      12767.96         63.84
         30.00      10808.63         54.04
         36.00       8784.76         43.92
         42.00       6694.22         33.47
         48.00       4534.80         22.67
         54.00       2304.25         11.52
         60.00          0.21          0.00
```

Problem 11

Script file:

```
clear, clc
format short g
alt=-500:500:10000;
p=29.921*(1-6.8753e-6*alt);
Tb=49.16*log(p)+44.932;
tbl=[alt' Tb'];
disp('                    Boiling')
disp('       Altitude   Temperature')
disp('         (ft)       (degF)')
disp(tbl)
```

Command Window:

```
                Boiling
      Altitude   Temperature
        (ft)       (degF)
        -500       212.17
           0       212.01
         500       211.84
        1000       211.67
        1500        211.5
        2000       211.32
        2500       211.15
        3000       210.98
        3500       210.81
        4000       210.63
        4500       210.46
        5000       210.29
        5500       210.11
        6000       209.93
        6500       209.76
        7000       209.58
        7500        209.4
        8000       209.22
        8500       209.04
        9000       208.87
        9500       208.68
       10000        208.5
```

Problem 12

Script file:

```
clear, clc
a=10:.1:120;
h=2*600./a;
theta=atan(a./(2*h));
height=h+2+2./sin(theta);
base=2*height.*tan(theta);
[min_area indx] = min(0.5*base.*height);
inner_base=a(indx)
inner_height=h(indx)
outer_base=base(indx)
outer_height=height(indx)
```

Command Window:

```
inner_base =
   37.2000
inner_height =
   32.2581
outer_base =
   44.1237
outer_height =
   38.2620
```

Problem 13

Script file:

```
clear, clc
a=5:.25:100; R=55;
b=sqrt((2*R)^2-a.^2);
h=b-20; w=a-8;
[max_area indx] = max(h.*w);
width_a=a(indx)
height_b=b(indx)
```

Command Window:

```
width_a =
   74.5000
height_b =
   80.9305
```

Problem 14

Script file:

```
clear, clc
vrun=3; vswim=1; L=48; ds=30; dw=42;
y=20:1:48;
ls = sqrt(y.^2+ds^2);
lw = sqrt((L-y).^2+dw^2);
t=ls/vrun + lw/vswim;
[tmin indx] = min(t);
min_t=t(indx)
y_at_min=y(indx)
phi = atan(y_at_min/ds);
alpha = atan((L-y_at_min)/dw);
sin_ratio=sin(phi)/sin(alpha)
speed_ratio=vrun/vswim
```

Command Window:

```
min_t =
   59.2946
y_at_min =
    37
sin_ratio =
    3.0658
speed_ratio =
     3
```

Discussion: The minimum time is 59.29 seconds with the lifeguard entering the water at 37 m. Snell's law seems only approximately satisfied, but this is due to the relatively large increment in y. The ratio converges to Snell's law as the increment decreases. For example, decreasing the increment to .01 gives a sine ratio of 2.9996.

Problem 15

Script file:

```
clear, clc
H=70; h=900;
x=50:.5:1500;
theta=atan(h./x)-atan((h-H)./x);
[max_th indx]=max(theta);
disp('The best target view occurs at a distance in feet of')
disp(x(indx))
```

Command Window:

```
The best target view occurs at a distance in feet of
  864.5000
```

Problem 16

Script file:

```
clear, clc
load stress_data.txt
M=stress_data(1); b=stress_data(2); t=stress_data(3); a=stress_data(4);
alpha=a/b; beta=pi*alpha/2;
C=sqrt(tan(beta)/beta)*((0.923+0.199*(1-sin(beta))^2)/cos(beta));
sigma=6*M/(t*b^2);
K=C*sigma*sqrt(pi*a);
fprintf('The stress intensity factor for a beam that is %.2f m wide',b)
fprintf(' and %.2f m thick\nwith an edge crack of %.2f m and an',t,a)
fprintf(' applied moment of %.0f is %.0f pa-sqrt(m).\n',M,K)
```

Text File (stress_data.txt):

```
20 .25 .01 .05
```

Command Window:

```
The stress intensity factor for a beam that is 0.25 m wide and 0.01 m thick
with an edge crack of 0.05 m and an applied moment of 20 is 82836 pa-sqrt(m).
```

Problem 17

Script file:

```
clear, clc
v=50; rho=2000; h=500;
t_90=pi*rho/(2*v);
t=linspace(0,t_90,15);
alpha=v*t/rho;
r=sqrt(rho^2 + (h+rho)^2 - 2*rho*(rho+h)*cos(alpha));
theta=90-asind(rho*sin(alpha)./r);
fprintf('For a plane flying at a speed of %.0f m/s in a circular path ',v)
fprintf('of radius %.0f m\ncentered above the tracking station and ',rho)
fprintf('%.0f m above the station at its lowest point:\n\n',h)
%fprintf accesses elements column by column
%can also use disp as shown in problem 11
tbl=[t;theta;r];
fprintf('    Time      Tracking       Distance\n')
fprintf('     (s)     Angle (deg)        (m)\n')
fprintf('    %4.1f        %4.1f          %6.1f\n',tbl)
```

Command Window:

```
For a plane flying at a speed of 50 m/s in a circular path of radius 2000 m
centered above the tracking station and 500 m above the station at its lowest
point:
```

Time (s)	Tracking Angle (deg)	Distance (m)
0.0	90.0	500.0
4.5	66.4	559.4
9.0	51.0	707.6
13.5	42.8	900.6
18.0	38.8	1113.7
22.4	37.2	1335.2
26.9	36.9	1559.4
31.4	37.5	1783.0
35.9	38.7	2003.8
40.4	40.3	2220.3
44.9	42.2	2431.3
49.4	44.3	2635.8
53.9	46.5	2832.8
58.3	48.9	3021.6
62.8	51.3	3201.6

Problem 18

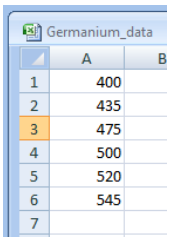
Script file:

```
clear, clc
C=13.83; Eg=0.67; k=8.62e-5;
T=xlsread('Germanium_data.xlsx');
sigma=exp(C-Eg./(2*k*T));
tbl=[T sigma];
disp('                 Intrinsic')
disp('   Temperature  Conductivity')
disp('      deg K      (ohm-m)^-1')
%can also use disp as shown in problem 11
fprintf('      %4.0f         %5.1f\n',tbl')
```

Command Window:

Temperature deg K	Intrinsic Conductivity (ohm-m)^-1
400	61.2
435	133.7
475	283.8
500	427.3
520	576.1
545	811.7

Excel File:



Problem 19

Script file:

```
clear, clc
rho=input('Please input the fluid density in kg/m^3: ');
v=input('Please input the fluid velocity in m/s: ');
d_ratio=input('Please input the pipe diameter ratio as a vector [x x x]: ');
delP=0.5*(1-d_ratio.^2).^2*rho*v^2;
fprintf('\nFor gasoline with a density of %.0f kg/m^3 and a flow ',rho)
fprintf('velocity of %.1f m/s\n\n',v)
tbl=[d_ratio;delP];
disp('             delta P')
disp('    d/D        (Pa)')
fprintf('    %3.1f      %6.1f\n',tbl)
```

Command Window:

```
Please input the fluid density in kg/m^3: 737
Please input the fluid velocity in m/s: 5
Please input the pipe diameter ratio as a vector [x x x]: [.9:-.1:.4 .2]

For gasoline with a density of 737 kg/m^3 and a flow velocity of 5.0 m/s

             delta P
    d/D        (Pa)
    0.9       332.6
    0.8      1193.9
    0.7      2396.2
    0.6      3773.4
    0.5      5182.0
    0.4      6500.3
    0.2      8490.2
```

Problem 20

Script file:

```
clear, clc
sigma=5.669e-8;
T1=input('Please input the temperature of plate 1 in deg K: ');
T2=input('Please input the temperature of plate 2 in deg K: ');
a=input('Please input the radius of plate 1 in m: ');
b=input('Please input the radius of plate 2 in m: ');
c=input('Please input the distance between plate 1 and plate 2 in m: ');
X=a./c; Y=c/b; Z=1+(1+X.^2).*Y.^2;
F_1_2 = 0.5*(Z-sqrt(Z.^2-4*X.^2.*Y.^2));
q=sigma*pi*b^2*F_1_2*(T1^4-T2^4);
fprintf('\nFor circular plate 1 with radius %i m and temperature %i',a,T1)
fprintf(' deg K\nand circular plate 2 with radius %i m and temperature',b)
fprintf(' %i deg K\n',T2)
tbl=[c;q];
fprintf('\n                        Radiation\n')
fprintf('      Separation     Heat Exchange\n')
fprintf('          (m)           (Watts)\n')
fprintf('         %4.1f            %6.0f\n',tbl)
```

Command Window:

```
Please input the temperature of plate 1 in deg K: 400
Please input the temperature of plate 2 in deg K: 600
Please input the radius of plate 1 in m: 1
Please input the radius of plate 2 in m: 2
Please input the distance between plate 1 and plate 2 in m: 10.^(-1:1)

For circular plate 1 with radius 1 m and temperature 400 deg K
and circular plate 2 with radius 2 m and temperature 600 deg K

                      Radiation
      Separation     Heat Exchange
          (m)           (Watts)
          0.1            -18461
          1.0            -14150
         10.0              -706
```

Problem 21

Script file:

```
clear, clc
x1=input('Please enter the coordinates of point 1 as a vector [x x]: ');
x2=input('Please enter the coordinates of point 2 as a vector [x x]: ');
x3=input('Please enter the coordinates of point 3 as a vector [x x]: ');
A=2*[x1(1)-x2(1) x1(2)-x2(2); x2(1)-x3(1) x2(2)-x3(2)];
B=[x1(1)^2+x1(2)^2-x2(1)^2-x2(2)^2; x2(1)^2+x2(2)^2-x3(1)^2-x3(2)^2];
C=A\B;
r=sqrt((x1(1)-C(1))^2 + (x1(2)-C(2))^2);
fprintf('\nThe coordinates of the center are (%.1f, %.1f) ',C)
fprintf('and the radius is %.1f.\n',r)
```

Command Window:

```
Please enter the coordinates of point 1 as a vector [x x]: [10.5, 4]
Please enter the coordinates of point 2 as a vector [x x]: [2, 8.6]
Please enter the coordinates of point 3 as a vector [x x]: [-4, -7]

The coordinates of the center are (2.5, -0.6) and the radius is 9.2.
```

Problem 22

Script file:

```
clear, clc
T=[cosd(48.81) 1 0 0 0 0 0 0
    0 -1 0 0 cosd(48.81) 1 0 0 0
    0 0 1 0 sind(48.81) 0 0 0 0
    -cosd(48.81) 0 0 1 0 0 0 0 0
    -sind(48.84) 0 -1 0 0 0 0 0 0
    0 0 0 -1 -cosd(48.81) 0 0 0 0
    0 0 0 0 -sind(48.81) 0 -1 0 -sind(45)
    0 0 0 0 0 0 0 0 sind(45)
    0 0 0 0 0 0 0 -1 -cosd(45)];
A=[0; 0; 0; 0; 1800; 1200; 0; 1500; 0];
N=1:9;
F=T\A;
tbl=[N;F'];
disp(' ')
disp('  Member      Force')
disp('    No.        lbf')
fprintf('     %1i       %7.1f\n',tbl)
```

Command Window:

```
  Member      Force
    No.        lbf
     1       -2106.6
     2        1387.3
     3        -214.0
     4       -1387.3
     5         284.4
     6        1200.0
     7       -1714.0
     8       -1500.0
     9        2121.3
```

Problem 23

Script file:

```
clear, clc
T=[.7071 1 0 0 0 0 0 0 0 0 0 0 0; 0 -1 0 0 0 1 0 0 0 0 0 0 0; ...
    0 0 1 0 0 0 0 0 0 0 0 0 0; -.7071 0 0 1 .6585 0 0 0 0 0 0 0 0; ...
    .7071 0 1 0 .7526 0 0 0 0 0 0 0 0; 0 0 0 -1 0 0 1 .6585 0 0 0 0 0; ...
    0 0 0 0 0 0 0 .7526 1 0 0 0 0; 0 0 0 0 -.6585 -1 0 0 0 1 0 0 0; ...
    0 0 0 0 .7526 0 0 0 1 0 0 0 0; 0 0 0 0 0 0 -1 0 0 0 .7071 0 0; ...
    0 0 0 0 0 0 0 0 0 0 .7071 1 0; 0 0 0 0 0 0 0 0 .7526 0 0 0 1 0; ...
    0 0 0 0 0 0 0 0 0 0 .7071 0 1];
A=[0; 0; 2000; 0; -2000; 0; 0; 0; 1000; 0; -3000; 2000; 0];
N=1:13; F=T\A;
tbl=[N;F'];
disp(' ')
disp('  Member      Force')
disp('    No.        lbf')
fprintf('    %2i       %7.1f\n',tbl)
```

Command Window:

```
  Member      Force
    No.        lbf
     1       -6741.2
     2        4766.7
     3        2000.0
     4       -5437.5
     5        1018.7
     6        4766.7
     7       -5233.3
     8        -310.0
     9         233.3
    10        5437.5
    11       -7401.1
    12        2233.3
    13        5233.3
```

Problem 24

Script file:

```
clear, clc
x=[-2.6 0.5 1.5 3.5]; y=[-68; 5.7; 4.9; 88]; power=3:-1:0;
X=[x(1).^power; x(2).^power; x(3).^power; x(4).^power];
coefs=X\y;
fprintf('\nThe equation is f(x)=%.3fx^3 + %.3fx^2 + %.3fx + %.3f\n',coefs)
```

Command Window:

```
The equation is f(x)=3.297x^3 + -4.016x^2 + -3.483x + 8.033
```

Problem 25

Script file:

```
c=1; t=0.2;
x=[.15 .35 .5 .7 .85]; y=[.08909 .09914 .08823 .06107 .03421];
A=sqrt(x/c); B=x/c; C=(x/c).^2; D=(x/c).^3; E=(x/c).^4;
X=[A' B' C' D' E']; Y=0.2*y'/(t*c);
coefs=X\Y;
fprintf('The coefficients are:\n')
fprintf('a0=%.4f, a1=%.4f, a2=%.4f, a3=%.4f, a4=%.4f\n',coefs)
```

Command Window:

```
The coefficients are:
a0=0.2969, a1=-0.1258, a2=-0.3526, a3=0.2861, a4=-0.1025
```

Problem 26

Script file:

```
clear, clc
X=[1 2 1 1; 2 3 0 1; 1 4 1 0; 1 3 2 0]; Y=[5; 12; 11; 8];
coefs=X\Y;
fprintf('The scoring values are:\nEagle: %.1f\nBirdie: %.1f\n',coefs(1:2))
fprintf('Bogey: %.1f\nDouble: %.1f\n',coefs(3:4))
```

Command Window:

```
The scoring values are:
Eagle: 4.0
Birdie: 2.0
Bogey: -1.0
Double: -2.0
```

Problem 27

Script file:

```
clear, clc
X=[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];
disp('Try a=1')
Y=[0; 0; 0; 0; 0; 0; 1];
coefs=(X\Y)'
disp('Try a=2')
Y=[0; 0; 0; 0; 0; 0; 2];
coefs=(X\Y)'
disp('Try a=3')
Y=[0; 0; 0; 0; 0; 0; 3];
coefs=(X\Y)'
```

Command Window:

```
Try a=1
coefs =
    1.0000    2.6667    2.6667    1.0000    1.0000    2.6667    1.3333
Try a=2
coefs =
    2.0000    5.3333    5.3333    2.0000    2.0000    5.3333    2.6667
Try a=3
coefs =
    3.0000    8.0000    8.0000    3.0000    3.0000    8.0000    4.0000
```

Problem 28

Script file:

```
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];
%if using disp for table need round function
Twc=35.74+0.6215*T-35.75*v.^0.16+0.4275*T.*v.^0.16;
tbl=[vs Twc]';
fprintf('                          Temperature (F)\n        ')
fprintf('   %3i',Ts)
fprintf('\n    Speed\n   (mi/hr)\n')
fprintf('     %3.0f   %3.0f   %3.0f   %3.0f   %3.0f   %3.0f   %3.0f   %3.0f
%3.0f   %3.0f\n',tbl)
```

Command Window:

```
                    Temperature (F)
          40    30    20    10     0   -10   -20   -30   -40
   Speed
  (mi/hr)
     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
a_b=0:.05:.95;
C=0.265*(1-a_b)+(0.857+0.265*a_b)./(1-a_b).^1.5;
tbl=[a_b;C];
fprintf('    a/b          C\n')
fprintf('    %4.2f      %6.3f\n',tbl)
```

Command Window:

```
    a/b          C
    0.00       1.122
    0.05       1.192
    0.10       1.273
    0.15       1.370
    0.20       1.484
    0.25       1.620
    0.30       1.785
    0.35       1.985
    0.40       2.231
    0.45       2.539
    0.50       2.931
    0.55       3.441
    0.60       4.122
    0.65       5.063
    0.70       6.424
    0.75       8.512
    0.80      12.005
    0.85      18.669
    0.90      34.669
    0.95      99.183
```