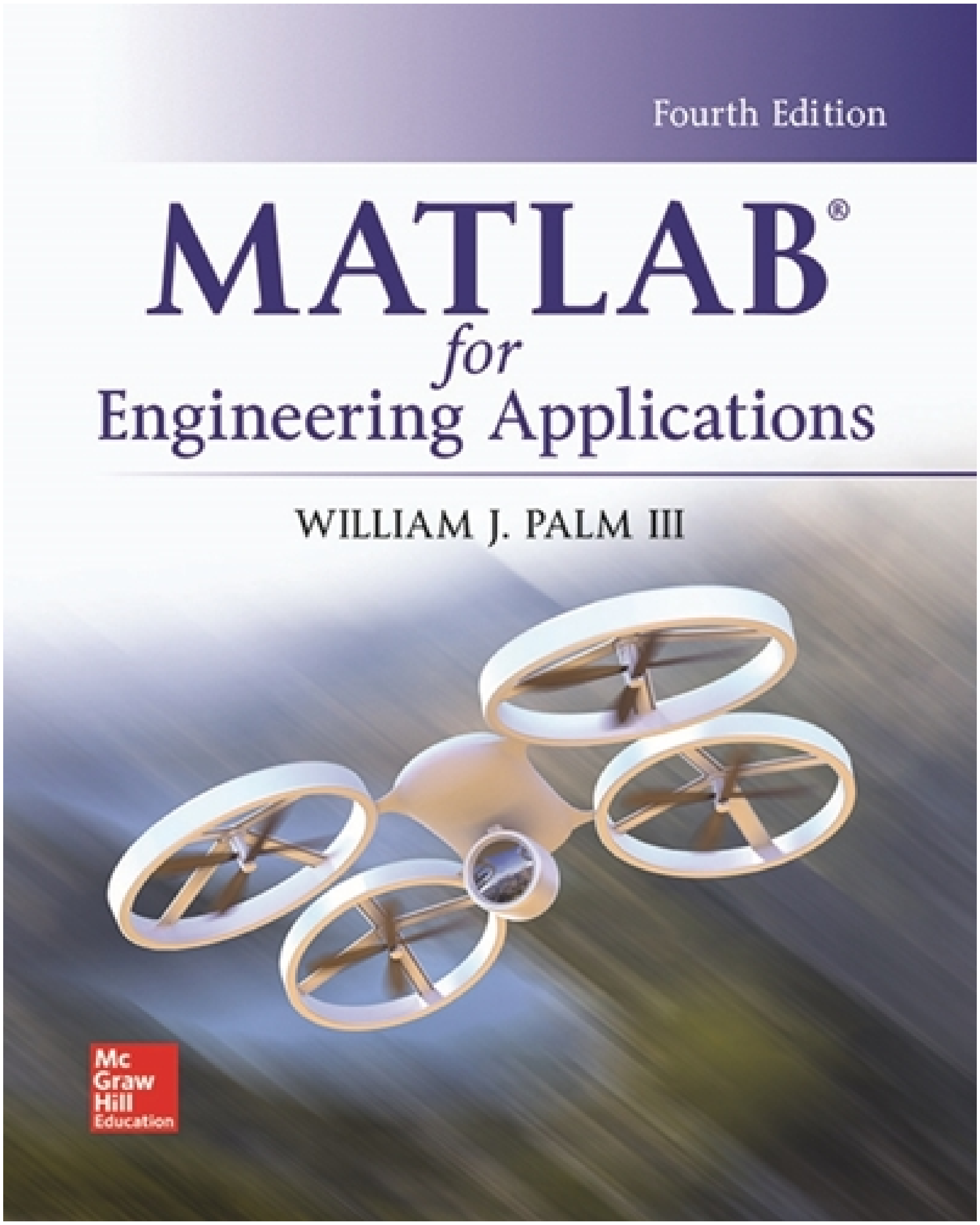
Solutions for MATLAB for Engineering Applications 4th Edition by Palm



Solutions

Solutions Manual©

to accompany

MATLAB for Engineering Applications, Fourth Edition

by

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Solutions to Problems in Chapter Two

Test Your Understanding Problems

T2.1-1 The session is

```
>>B = [2,4,10,13;16,3,7,18;8,4,9,25;3,12,15,17];
>>A=[B;B']
>>A(5,3)
8
```

T2.1-2 a) The session is

```
>>B = [2,4,10,13;16,3,7,18;8,4,9,25;3,12,15,17];
>>[x,k] = max(B);
>>[maxB,column]=max(x)
 maxB =
      25
 column
      4
>>row=k(column)
row
     3
```

b) Continue the above session as follows:

```
>>C = sort(B)
C =
       2     3     7     13
       3     4     9     17
       8     4    10     18
       16    12    15     25
```

T2.3-1

```
>> x = [6,5,10]; y = [3,9,8];
>> s =  x+y;
>> w = x.*y;
>> z = y.*x
```

Answers a. s = [9, 14, 18]   b. w= [18, 45, 80] c. z= [18, 45, 80]. The same.

T2.3-2

```
>>A=[6,4;5,3]; B=[5,2;7,9];
>>S = A+B;
>>w = A.*B;
>> z = B.*A;
```

Answers a. S = [11, 6; 12, 12] b. w= [30, 8; 35, 27] c. z= [30, 8; 35, 27]. Yes.

T2.3-3

```
>>x=[6,5,10];
>>y=[3,9,8];
>>w=x./y;
>>z=y./x;
```

Answers a. w=[2, 0.5556, 1.25]   b. z=[0.5, 1.8, 0.8]

T2.3-4

```
>>A=[6,4;5,3];
>>B=[5,2;7,9];
>>C=A./B;
>>D=B./A;
>>E=A.\B;
>>F=B.\A;
```

Answers. a. C=[1.2, 2; 0.7143, 0.3333] b. D=[0.8333, 0.5; 1.4, 3] c. E= [0.8333, 0.5; 1.4, 3] d. F=[1.2, 2; 0.7143, 0.3333] e. C and F are the same; D and E are the same.

T2.3-5 a) The session is

```
>>A = [21,27;-18,8];B = [-7,-3;9,4];
>>A.*B
ans
     -147   -81
     -162    32
>>A./B
ans
     -3     -9
     -2      2
>>B.^3
ans
      -343   -27
      729    64
```

T2.4-1

```
>>x=[6;5;3];
>>y=[2,8,7];
>>w=x*y;
>>z=y*x;
```

Answers. a. w=[12, 48, 42; 10, 40, 35; 6, 24, 21] b. z=73, obviously no!

T2.4-2 The session is

```
>>u = [6,-8,3]; w = [5,3,-4]
>>u*w'
ans
     -6
```

T2.4-3 The session is

```
>>A = [7,4;-3,2;5,9];B = [1,8;7,6]
>>A*B
ans
     35    80
     11   -12
     68    94
```

T2.4-4 The session is:

```
>>A = [4,3;8,2];
>>b = [23;6];
>>x = A\b
x =
      2.0000
      5.0000
```

To check the answer, compute the right-hand sides:

```
>>A*x
ans
     23    6
```

Thus the correct solution is x=2, y=-5.

T2.4-5 The session is

```
>>A = [4,-2;3,5];b = [16;-1]
>>x = A\b
x =
    3.0000
     -2.0000
```

To check the answer, compute the right-hand sides:

```
>>A*x
ans
     16     -1
```

Thus the correct solution is x=3, y=-2.

T2.4-6 The session is:

```
>>A = [6, -4, 8; -5, -3, 7; 14, 9, -5];
>>b = [112; 75; -67];
>>x = A\b
x =
     2.0000
     -5.0000
     10.0000
```

To check the answer, compute the right-hand sides:

```
>>A*x
ans
     112     75     -67
```

Thus the correct solution is x=2, y=-5, and z=10.

T2.5-1 The session is

```
>>roots([1,13,52,6])
ans
    -6.4406 + 2.9980i
    -6.4406 - 2.9980i
     -0.1189
>>poly(ans)
ans
     1.0000   13.0000   52.0000    6.0000
```

T2.5-2 The session is

```
>>p1 = [20,-7,5,10];p2 = [4,12,-3]
>>conv(p1,p2)
ans
     80    212   -124    121    105    -30
```

T2.5-3 The session is

```
>>p1 = [12,5,-2,3];p2 =[3,-7,4 ]
>>[q,r] = deconv(p1,p2)
q =
     4.0000    11.0000
r =
     0     0.0000    59.0000   -41.0000
```

T2.5-4 The session is

```
>>p1 = [6,4,0,-5];p2 = [12,-7,3,9]
>>ratio = polyval(p1,2)/polyval(p2,2)
ratio =
   0.7108
```

Using the deconv command, the session is

```
>>p1 = [6,4,0,-5]; p2 = [12,-7,3,9]
>>[q,r] = deconv(p1,p2);
>>ratio = polyval(q,2)+polyval(r,2)/polyval(p2,2)
ratio =
   0.7108
```

T2.5-5 The session is

```
>>x = -7:0.01:1;
>>plot(x,polyval([1,13,52,6],x)),xlabel('x'),ylabel('y')
```

T2.7-1 The script file is

```
student(1).name = 'John Smith';
student(1).number = '392771786';
student(1).email = 'smithj@myschool.edu';
student(1).tests = [67,75,84];
student(2).name = 'Mary Jones';
student(2).number = '431569832';
student(2).email = 'jonesm@myschool.edu';
student(2).tests = [84,78,93];
student(3).name = 'Alfred E. Newman';
student(3).number = '555123456';
student(3).email = 'NewmanA@myschool.edu';
student(3).tests = [55,45,58];
```

T2.7-2 The session is

```
>>student(3).tests(2) = 53;
```

T2.7-3 The session is

```
>>new_student = rmfield(student,'SSN')
```

End-of-Chapter Problems

2.1 a) Either `x = [5:23/99:28]` or `x = linspace(5,28,100)` will work.

b) Either `x = [2.:0.2:14]` or `x=linspace(2,14,61)}` will work.

c) Either `x = [-2:1/7:5]` or Either `x =linspace(-2,5,50)` will work.

2.2 a) Type `x= logspace(10,1000,50);` b) Type `x=logspace(10,1000,20);`

2.3 The session is

```
>>x = linspace(0,10,6);
>>A = [3*x;5*x-20]
A =
     0      6     12     18     24     30
     -20    -10     0     10     20     30
```

2.4 Use the transpose operator. The session is

```
>>x = linspace(0,10,6);
>>A = [3*x;5*x-20]'
A =
      0     -20
      6     -10
     12       0
     18     10
     24     20
     30     30
```

2.5 The session is

```
>>A = [3,7,-4,12;-5,9,10,2;6,13,8,11;15,5,4,1];
>> v = A(:,2);
>> w = A(2,:);
```

2.6 The session is

```
>>A = [3,7,-4,12;-5,9,10,2;6,13,8,11;15,5,4,1];
>>B = A(:,2:4);
>>C = A(2:4,:);
>>D = A(1:2,2:4);
```

2.7 The length is 3 for all three vectors. The following session computes the absolute values.

```
>>x = [2,4,7];
>>length(x)
ans
     3
>>abs(x)
ans
     2     4     7
>>y=[2,-4,7];
>>abs(y)
ans
     2     4     7
>>z=[5+3i,-3+4i,2-7i];
>>abs(z)
ans
     5.8310    5.0000    7.2801
```

2.8 The session is

```
>>A = [3,7,-4,12;-5,9,10,2;6,13,8,11;15,5,4,1];
>>min(A)
ans
     -5      5     -4      1
>>max(A)
ans
15     13     10     12
>>min(A')
ans
     -4     -5      6      1
>>max(A')
ans
     12     10     13     15
```

2.9 The session is

```
>>A = [3,7,-4,12;-5,9,10,2;6,13,8,11;15,5,4,1];
>> B = sort(A)
 B =
      -5     5    -4     1
     3     7     4     2
     6     9     8    11
     15    13    10    12
>>C = [sort(A')]'
 C =
      -4     3     7    12
      -5     2     9    10
       6     8    11    13
       1     4     5    15
>>D = sum(A)
 D =
     19    34    18    26
>>E = sum(A')
 E =
     18    16    38    25
```

2.10 a) The session is

```
>>A = [1,4,2;2,4,100;7,9,7;3,pi,42];
>>B = log(A)
>>B(2,:)
```

The answers are 0.6931, 1.3863, and 4.6052.

b) Type `sum(B(2,:))`. The answer is 6.6846.

c) Type `B(:,2).*A(:,1)`. The answers are 1.3863, 2.7726, 15.3806, 3.4342.

d) Type `max(B(:,2).*A(:,1))`. The answer is 15.3806.

e) Type `sum(A(1,:)./B(1:3,3)')`. The answer is 3.3391.

2.11 The script file is

```
A = [3,-2,1;6,8,-5;7,9,10];
B = [6,9,-4;7,5,3;-8,2,1];
C = [-7,-5,2;10,6,1;3,-9,8];
D(:,:,1) = A;
D(:,:,2) = B;
D(:,:,3) = C;
max(max(D))
max(max(max(D)))
```

While this file is run, it produces the results:

```
ans(:,:,1) =
     10
ans(:,:,2) =
     9
ans(:,:,3) =
     10
ans
     10
```

Thus the largest element in the first, second, and third layer is 10, 9, and 10 respectively. The largest element in the entire array
is 10.

2.12

```
>>x = [5,9,-3];y=[7,4,2];
>>S = x+y;
>>w = x.*y;
>>z = y.*x;
```

Answers. a. s=[12, 13, -1]   b. w=[35, 36, -6] c. The same.

2.13

```
>>A = [9,6;2,7];B=[8,9;6,2];
>>w = A.*B;
>>z = B.*A;
```

Answers. a. w=[17, 15; 8, 9]   b. z=[72, 54; 12, 14]   c. Yes.

2.14

```
>>x = [10,8,3]y = [9,2,6];
>>w = x./y;
>>z = y./x;
```

Answers. a. w=[1.1111, 4, 0.5] b. z=[0.9, 0.25, 2]

2.15 The session is

```
>>A = [-7,11;4,9]; B = [4,-5;12,-2]; C = [-3,-9;7,8];
>>A+B+C
ans
     -6      -3
     23     15
>> A-B+C
ans
     -14     7
     -1     19
>>(A+B)+C
ans
     -6      -3
     23     15
>>A+(B+C)
ans
     -6      -3
     23     15
>> B+C+A
ans
     -6      -3
     23     15
>>A+C+B
ans
     -6      -3
     23     15
```

2.16

```
>>A = [5,9;6,2];B=[4,7;2,8];
>>C = A./B;
>>D = B./A;
>>E = A.\B;
>>F = B.\A;
```

Answers. a. C= [1.25, 1.2857; 3, 0.25] b. D=[0.8, 0.7778; 0.3333, 4] c. E=[0.8, 0.7778; 0.3333, 4] d. F=[1.25, 1.2857; 3, 0.2500] e. `C` and `F` are equal. `D` and `E` are equal.

2.17 The session is

```
>>A = [56,32;24,-16]; B = [14,-4;6,-2];
>>A.*B
ans
     784         -128
     144           32
>> A/B
ans
     176    -168
     -12      32
>> B.^3
ans
     2744          -64
     216           -8
```

2.18 The script is

```
% Part a
v0 = 100;A = 35;g=9.81;
% t_guess = 10;
t_guess = input('Enter a guess for time to hit:  ')
d = t_guess/1000;
t = [0:d:t_guess];
y =( v0*sind(A))*t-0.5*g*t.^2;
% y_max is the maximum height; t_max is the time to reach y_max.
[y_max,i_max] = max(y)
t_max = d*i_max
t_hit = 2*t_max
% Part b
clear t y
t = [0:d:2*t_max];
x = v0*cosd(A)*t;
y = (v0*sind(A))*t-0.5*9.81*t.^2;

Enter a guess for time to hit:  10
t_guess =
    10
y_max =
  167.6809
i_max =
   586
t_max =
    5.8600
t_hit =
   11.7200
```

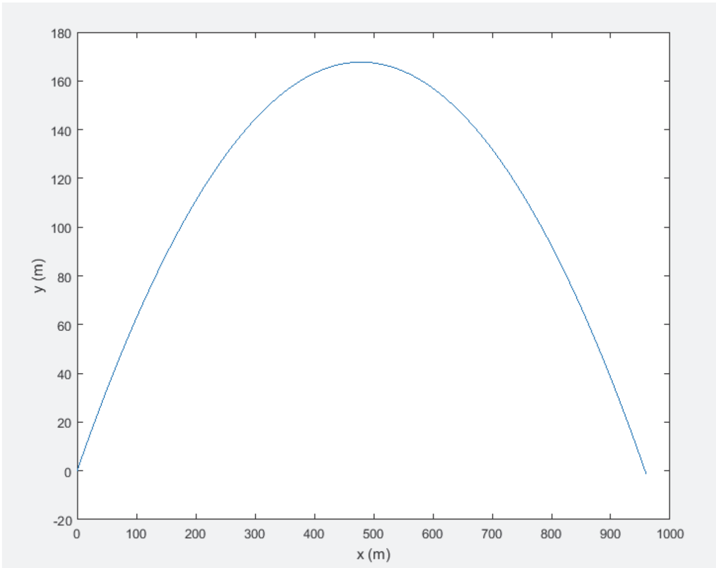

Figure for Problem 2.18

2.19 The session is:

```
>>x = linspace(-2,16,300);
>>f=(4*cos(x))./(x+exp(-0.75*x));
>>plot(x,f),xlabel('x'),ylabel('y')
```

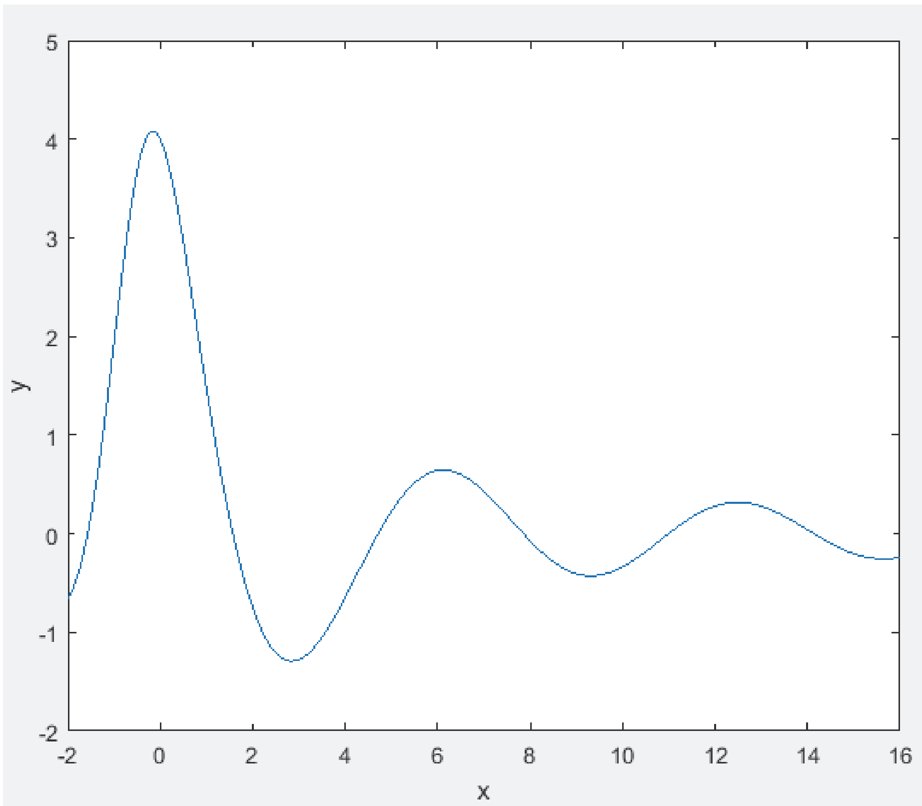

Figure for Problem 2.19

2.20 The session is:

```
>>x = linspace(-2*pi,2*pi,300);
>>f=3*x.*(cos(x)).^2-2*x;
>>plot(x,f),xlabel('x'),ylabel('y')
```

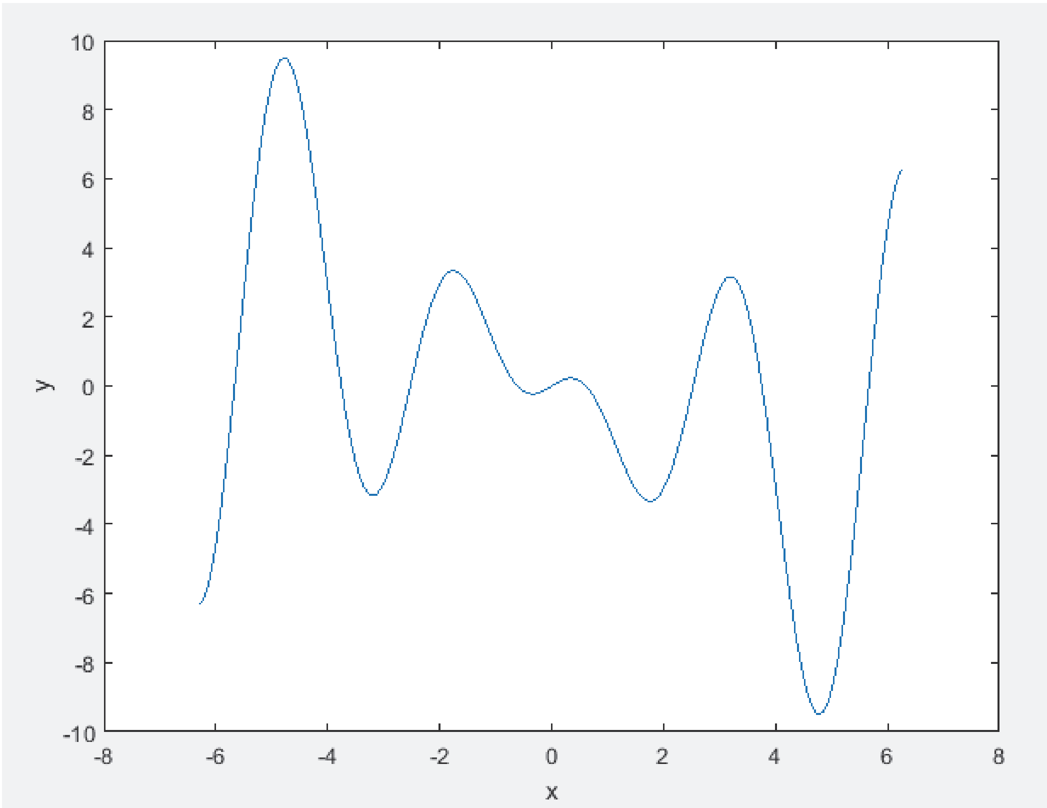

Figure for Problem 2.20

2.21 The session is:

```
>>x = linspace(-3.5,10,300);
>>f = 2.5.^(0.5*x).*sin(5*x);
>>plot(x,f),xlabel('x'),ylabel('y')
```

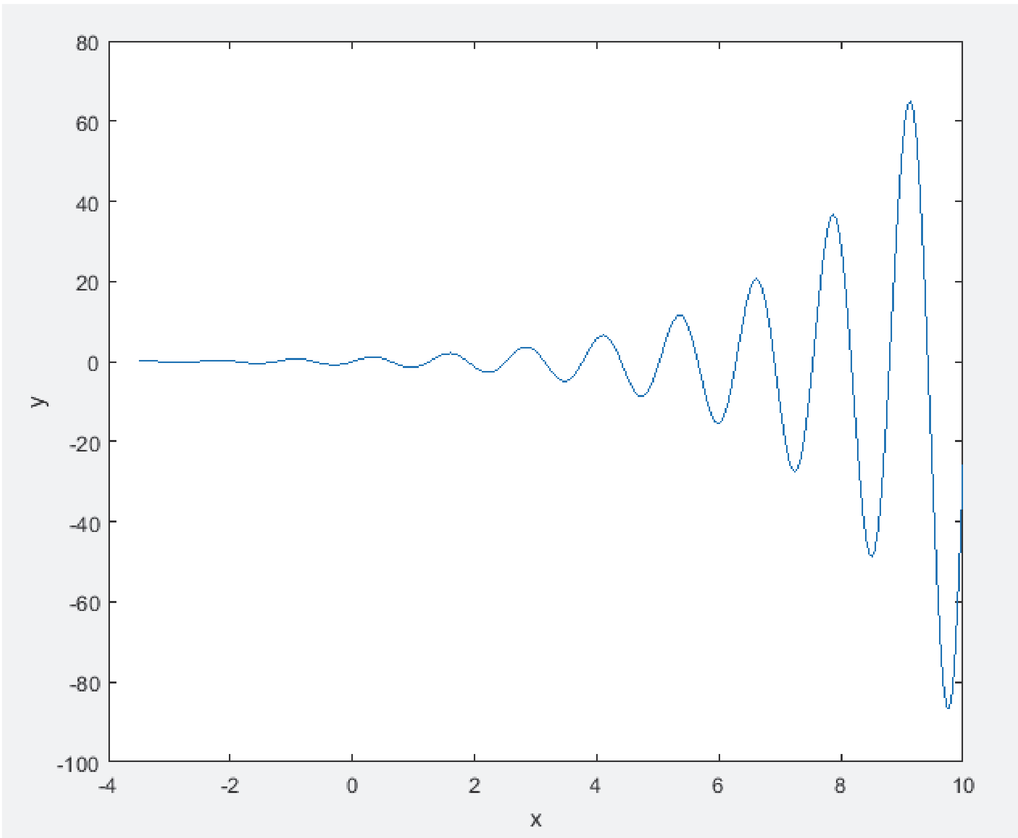

Figure for Problem 2.21

2.22 The session is:

```
>>x = linspace(-10,30,200);
>>y = 2*x-10;
>>D = sqrt(x.^2+y.^2);
>>min_dist=min(D)
```

The answer is D = 4.48 km.

2.23 The session is

```
>>F = [400,550,700,500,600]; D = [3,0.5,0.75,1.5,5];
>>W = F.*D
 W =
     1200         275         525         750        3000
>>Total_Work = sum(W)
 Total_Work =
     5750
```

The work done on each segment is 1200, 275, 750, and 3000 joules, respectively. (1 joule = 1 N m.) The total work done is 5750 joules.

2.24 Let the unit vectors **i** and **j** point east and north, respectively. Then the velocity of plane A is

$$\mathbf{v}_A = 300(-\cos 45^\circ \mathbf{i} - \cos 45^\circ \mathbf{j})$$

and the velocity of plane B is

$$\mathbf{v}_B = -150\mathbf{i}$$

The velocity of plane A relative to plane B is $\mathbf{v}_r = \mathbf{v}_A - \mathbf{v}_B$. The session is as follows:

```
>>v_A = 300*[-cos(pi/4),-cos(pi/4)];
>>v_B = [-150,0];
>>v_R = v_A - v_B
 v_R =
     -62.1320 -212.1320
>>s_R = sqrt(v_R(1)^2 + v_R(2)^2)
 s_R =
     221.0439
```

The relative velocity is $\mathbf{v}_R = -62.132\mathbf{i} - 212.132\mathbf{j})$ mi/hr. The relative speed is 221.0439 mi/hr. So Plane A is moving relative to plane B by 62.132 mi/hr to the west and 212.132 mi/hr to the south. The relative speed could also have been computed by s_R = sqrt(sum(v_R.*v_R)) or by s_R = sqrt(v_R*v_R').

2.25 The session is

```
>>wage = [5,5.5,6.5,6,6.25]; hours = [40,43,37,50,45];
>>output = [1000,1100,1000,1200,1100];
>>earnings = wage.*hours
 earnings =
     200.0000  236.5000  240.5000  300.0000  281.2500
>>total_salary = sum(earnings)
 total_salary =
     1.2582e+003
>>total_widgets = sum(output)
 total_widgets =
     5400
>>average_cost = total_salary/total_widgets
average_cost =
     0.2330
>>average_hours = sum(hours)/total_widgets
 average_hours =
     0.0398
>>[maximum,most_efficient] = max(output./earnings)
maximum =
     5
 most_efficient =
     1
>>[minimum,least_efficient] = min(output./earnings)
minimum =
     3.9111
 least_efficient =
     5
```

The workers earned $200, $236.50, $240.50, $300, and $281.25 respectively. The total salary paid out was $1258.20, and 5400 widgets were made. The average cost to produce one widget was 23.3 cents, and it took an average of 0.0398 hr to produce one widget. The first worker, who produced 5 widgets per dollar of earnings, was the most efficient. The fifth worker, who produced 3.911 widgets per dollar of earnings, was the least efficient.

2.26 Let the unit vectors **i**, **j**, and **k** point west, north, and down, respectively. Then the positions of the two divers are given by

$$\mathbf{D}_1 = -60\mathbf{i} - 25\mathbf{j} + 30\mathbf{k}$$
$$\mathbf{D}_2 = -30\mathbf{i} - 55\mathbf{j} + 20\mathbf{k}$$

The answer for (a) is given by $|\mathbf{D}_1|$; for (b) by $\mathbf{D} = \mathbf{D}_2 - \mathbf{D}_1$; and for (c) by $|\mathbf{D}|$. The session is

```
>>D_1 = [-60,-25,30]; D_2 = [-30,-55,20];
>>magD_1 = sqrt(D_1*D_1')
 magD_1 =
      71.5891
>>D = D_2 - D_1
 D =
     30   -30   -10
>>magD = sqrt(D*D')
 magD =
     43.5890
```

So diver 1 is 71.5891 ft from the starting point. To get to diver 2, diver 1 must swim 30 ft west, 30 ft south, and 10 ft up. To reach diver 2 in a straight line, diver 1 must swim 43.589 ft.

2.27 The session is

```
>>force = [11,7,8,10,9]; k = [1000,600,900,1300,700];
>>x = force./k
 x =
     0.0110    0.0117    0.0089    0.0077    0.0129
>>energy = 0.5*k.*x.^2
 energy =
     0.0605    0.0408    0.0356    0.0385    0.0579
```

The unit for compression is a meter; the unit for energy is a joule.

2.28 The session is:

```
>>price = [300,550,400,250,500];
>>quantity = [5,4,6;3,2,4;6,5,3;3,5,4;2,4,3];
>> monthly_expenses = [price'.*quantity(:,1),price'.*quantity(:,2),
price'.*quantity(:,3)]
 monthly_expenses =
     1500         1200         1800
     1650         1100         2200
     2400         2000         1200
     750         1250         1000
     1000         2000         1500
>>May_expenses = sum(monthly_expenses(:,1))
May_expenses =
     7300
>>June_expenses = sum(monthly_expenses(:,2))
 June_expenses =
     7550
>>July_expenses = sum(monthly_expenses(:,3))
 July_expenses =
      7700
>>three_month_total = sum(monthly_expenses')
three_month_total =
     4500         4950         5600         3000         4500
>>total = sum(three_month_total)
total =
     22550
```

2.29 The script file is:

```
A = 1600;
R = [0.01:0.01:40];
L = (A-0.5*pi*R.^2)./(2*R);
cost = 30*2*(R+L)+40*pi*R;
[mincost,k] = min(cost);
Rmin = R(k)
Lmin = L(k)
mincost
```

The answers are $R_{min} = 18.61$ ft and $L_{min} = 28.37$ ft. The minimum cost is $5157.

2.30 The script file is:

```
r = [2:0.01:10];V = 500;
h = (V-2*pi*r.^3/3)./(pi*r.^2);
cost = 600*pi*r.*h+800*pi*r.^2;
plot(r,cost),xlabel('Radius (meters)'),ylabel('Cost ($)'), …
      [radius,mincost] = ginput(1)
 hmin = (V-2*pi*radius.^3/3)./(pi*radius.^2)
```

The plot is shown in the figure. The minimum cost is $91334. The optimum radius is 4.8915 m. The required height is 3.3909 m.

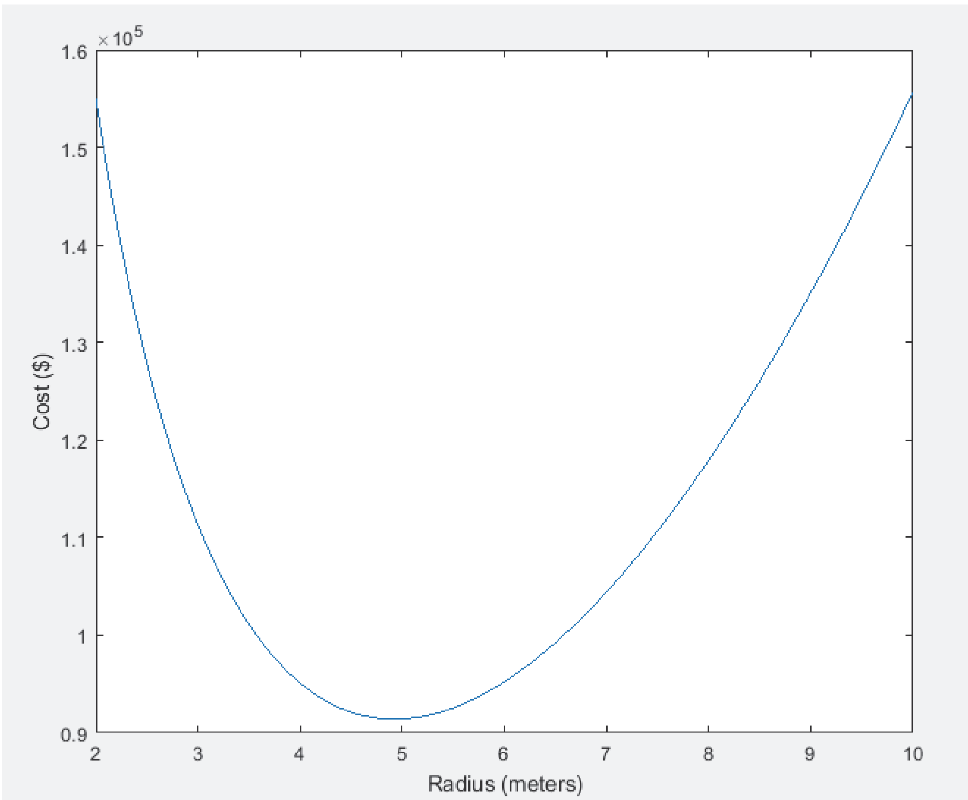

Figure for Problem 2.30

2.31 The MATLAB expressions are:

```
f = 1./sqrt(2*pi*c./x)
E = (x + w./(y + z))./(x + w./(y - z))
A = exp(-c./(2*x))./(log(y).*sqrt(d*z))
S = x.*(2.15 + 0.35*y).^1.8./(z.*(1-x).^y)
```

2.32 a) $C(t) = 0.5C(0)$ implies that $0.5 = e^{-kt}$. Solve for t: $t = -(\ln 0.5)/k$. The script file is:

```
k = [0.047:0.001:0.107];
thalf = -log(0.5)./k;
plot(k,thalf),xlabel('Elimination Rate Constant (1/hour)'), ylabel('Half-Life
(hours)')
```

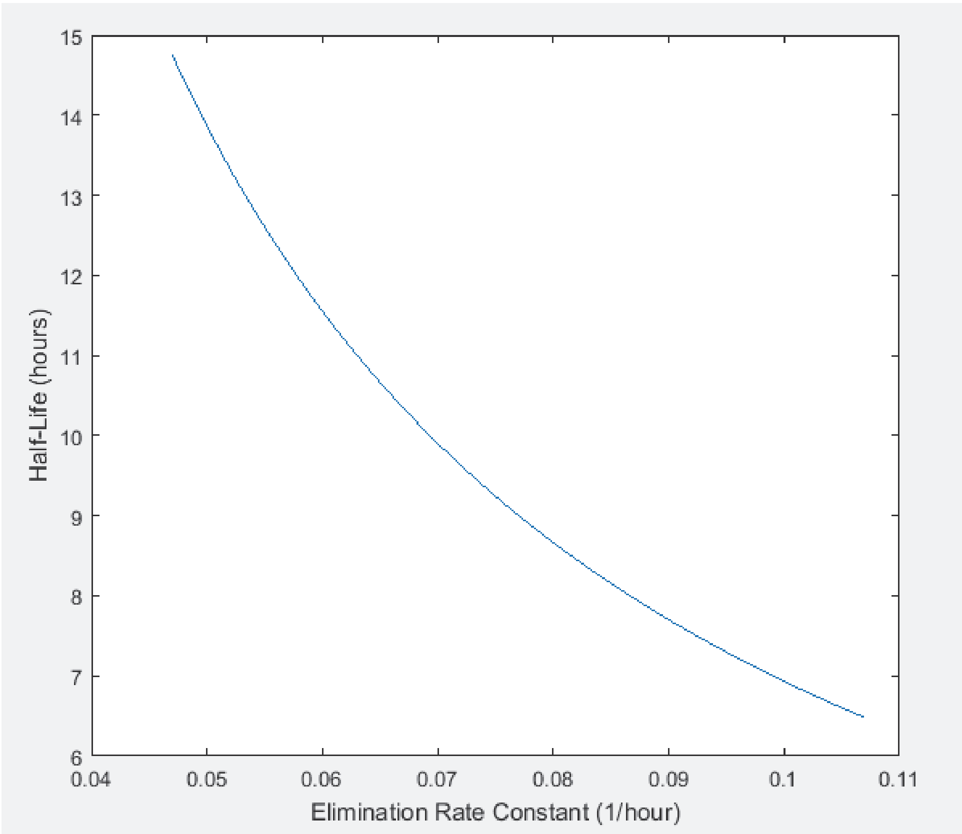

Figure for Problem 2.32a

Problem 2.32(b):

b) For $a=1$ and $t=1$, $C(t)=(1-e^{-k})/k$. The script file is:

```
k = [0.047:0.001:0.107];
C = (1 - exp(-k))./k;
plot(k,C),xlabel('Elimination Rate Constant (1/hour)'), ylabel('Concentration
(dimensionless)')
```

The plot is shown in the figure.

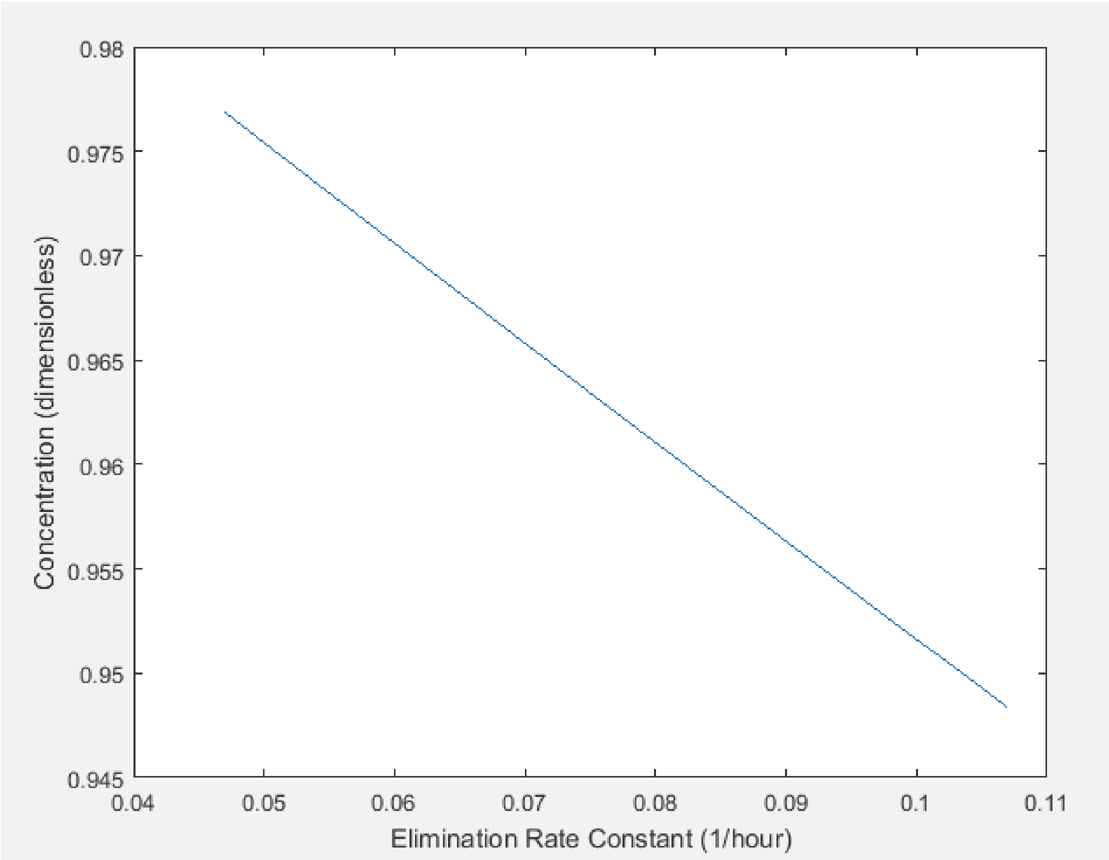

Figure for Problem 2.32b

CLICK HERE TO ACCESS THE COMPLETE Solutions

2.33 a) The script file is

```
W = 400; Lb = 3; Lc = 5;
D = [0:0.01:Lb];
T = Lb*Lc*W./(D.*sqrt(Lb^2-D.^2));
[minT, k] = min(T)
minD = D(k)
```

The solution is minT = 1.3333e+003 and minD = 2.12, which correspond to a tension of $T = 1333$ N and a distance of $D = 2.12$ m.

b) Append the following lines to the script file in part (a).

```
Dplot = [1.5:0.001:2.2];
upper =  1.1*minT
Tplot = Lb*Lc*W./(Dplot.*sqrt(Lb^2-Dplot.^2));
plot(Dplot,Tplot,[1.5,2.2],[upper,upper]),grid,ginput(1)
```

The upper tension value is $1.1(1333) = 1467.$ N. The intersection of the two lines on the plot gives the solution, which is approximately $D = 1.6$ m (1.62 is a more accurate value).

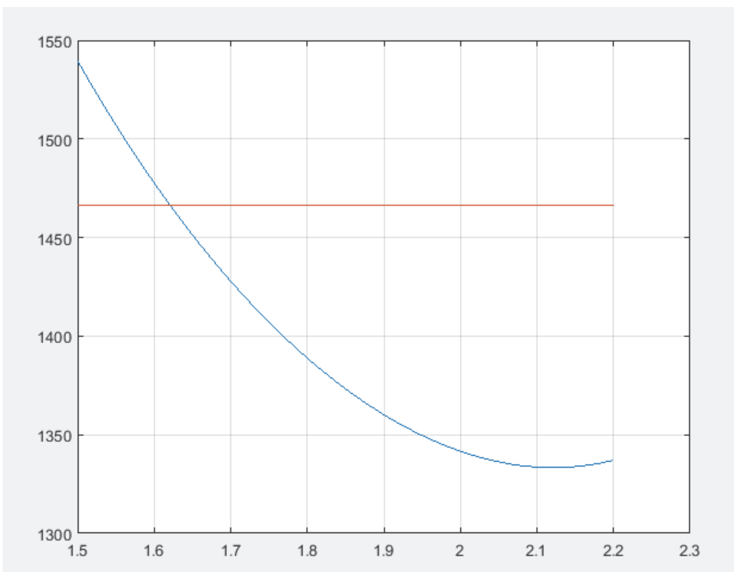

Figure for Problem 2.33b

2.34 The session is:

```
>>x=[3;7;2];
>>y=[4,9,5];
>>w = x*y;
>>z = y*x;
```

Answers. a. w=[12, 27, 15; 28, 63, 35; 8, 18, 10] b. z=85. No.

2.35 The session is:

```
>>x = [3;7;2];
>>A = [2,6,5;3,7,4;8,10;9];
>>y = A*x;
>>z = x*A;
```

Answers. a. y=[58; 66; 112] b. Undefined product because inner dimensions are not equal.

2.36 The session is

```
>>A = [11,5;-9,-4]; B = [ -7,-8;6,2];
>>A*B
ans
     -47       -78
     39         64
>>B*A
ans
     -5        -3
     48        22
```

2.37 The session is

```
>>A = [4,-2,1;6,8,-5;7,9,10]; B = [6,9,-4;7,5,3;-8,2,1];
>>C = [-4,-5,2;10,6,1;3,-9,8];
>>A*(B+C)
ans
     -31     -13      -7
     173     147     -25
     117      57     112
>>A*B+A*C
ans
     -31     -13      -7
     173     147     -25
     117      57     112
>>(A*B)*C
ans
     209            347            -136
      297           -111             308
     11207            562              250
>>A*(B*C)
ans
     209            347            -136
      297           -111             308
     11207            562              250
```

2.38 For part (a) note that the first quarter material cost is computed by

$$7(16)+3(12)+9(8)+2(14)+5(13)=326$$

and the second quarter material cost is computed by

$$7(14)+3(15)+9(9)+2(13)+6(16)=346$$

and so on. Thus the quarterly costs can be computed by multiplying the *transpose* of the matrix of unit costs by the matrix of quarterly production volumes. The resulting 3×4 matrix is quarterly_costs. Its first row contains the material costs, its second row contains the labor costs, and the third row contains the transportation costs. The four columns of quarterly_costs correspond to the four quarters. For part (b) the yearly costs for materials, labor, and transportation are found by summing the *rows* of quarterly_costs, or equivalently, by summing the *columns* of the transpose of quarterly_costs. For part (c) the total quarterly costs are found by summing the columns of quarterly_costs. The session is

```
>>unit_cost = [7,3,2;3,1,3;9,4,5;2,5,4;6,2,1];
>>quarterly_volume = [16,14,10,12;12,15,11,13;8,9,7,11;…
      14,13,15,17;13,16,12,18];
>>quarterly_costs = unit_cost'*quarterly_volume
quarterly_costs =

     326      346      268      364
     188      190      168      214
     177      186      160      204

>>yearly_costs = sum(quarterly_costs')
yearly_costs =

     1304             760             727

>>total_quarter_cost = sum(quarterly_costs)
total_quarter_cost

     691      722      596      782
```

(continued on the next page)

Problem 2.38 continued

The following table was created from the matrix quarterly_costs. All costs are in thousands of dollars.

Category	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Materials	326	346	268	364
Labor	188	190	168	214
Transportation	177	186	160	204

From the vector yearly_costs we obtain the following information:

yearly materials cost = $1,304,000,

yearly labor cost = $760,000,

and

yearly transportation cost = $727,000.

From the vector total_quarter_cost we find that the total costs in each quarter are $691,000, $722,000, $596,000, and $782,000 respectively.

2.39 The amount of copper (Cu) needed to produce 1000 tons of each alloy is obtained by multiplying the Cu column in the table by 1000(0.01) = 10. (The 0.01 is needed to convert the table's percents into decimal values.) Thus we need 1000(0.01)(4.4+0+0+1.6+0) = 60 tons of copper. Extending this method, we can see that we must multiply the matrix composition obtained from the table by a row vector consisting of five columns containing the value 10. The session is

```
>>composition = [4.4,1.5,.6,0,0;0,1,0,.6,0;0,1.4,0,0,4.5;  …
     1.6,2.5,0,0,5.6;0,.3,0,7,0];
>>alloy = 10*ones(1,5)
 alloy =
     10     10     10     10     10
 raw_material = alloy*composition
 raw_material =
      60.0000    67.0000     6.0000    76.0000   101.0000
```

Thus we need 60 tons of copper, 67 tons of magnesium, 6 tons of manganese, 76 tons of silicon, and 101 tons of zinc.

2.40 The script file is

```
%Enter the unit labor costs for the four products below.
labor1 = input('Enter the unit labor cost for product 1: ');
labor2 =  input('Enter the unit labor cost for product 2: ');
labor3 =  input('Enter the unit labor cost for product 3: ');
labor4 =  input('Enter the unit labor cost for product 4: ');
u1 = [6, 2, 4, 9];u3 = [1, 4, 2, 3];
u2 = [labor1,labor2,labor3,labor4];
U = [u1', u2', u3'];
P = [10, 12, 13, 15;8, 7, 6, 4;12, 10, 13, 9;6, 4, 11,5];
C = U'*P;
Quarterly_Costs = sum(U'*P);
Category_Costs = sum((U'*P)');
disp('The cost for quarter 1 is: ')
disp(Quarterly_Costs(1))
disp('The cost for quarter 2 is: ')
disp(Quarterly_Costs(2))
disp('The cost for quarter 3 is: ')
disp(Quarterly_Costs(3))
disp('The cost for quarter 4 is: ')
disp(Quarterly_Costs(4))
disp('The materials cost is: ')
disp(Category_Costs(1))
disp('The labor cost is: ')
disp(Category_Costs(2))
disp('The transportation cost is: ')
disp(Category_Costs(3))
```

The results are (in thousands of dollars):

The cost for quarter 1 is: 444

The cost for quarter 2 is: 391

The cost for quarter 3 is: 558

The cost for quarter 4 is: 392

The materials cost is: 760

The labor cost is: 709

The transportation cost is: 316

2.41 The position vector is $\mathbf{r} = [2, 10t + 3, 0]$. The session is

```
>>t = [0:.5:5];
>>P = [2*ones(1,length(t))',10*t'+3,zeros(1,length(t))'];
>>location_5 = P(11,:)
location_5 =
     2     53      0
>>v = [0,10,0];
>>L = 5*cross(P(11,:),v)
 L =
     0      0     100
```

The location of the mass at $t = 5$ s is given by the vector location_5. The location's coordinates are $x = 2$, $y = 53$, $z = 0$ m. The angular momentum vector at $t = 5$ s is $L = 0\mathbf{i} + 0\mathbf{j} + 100\mathbf{k}$. It lies entirely in the z direction, and has a magnitude of 100 kg m^2/sec.

2.42 The session is

```
>>F = [12,-5,4];
>>r = [-3,5,2];
>>n = [6,5,-7];
>>M = dot(cross(r,F),n)
 M =
     8675
```

The magnitude is $M = 675$ N m.

2.43 The session is

```
>>A = [7, -3, 7]; B = [-6, 2, 3]; C = [2, 8, -8];
>>left = cross(A,cross(B,C))
 left =
     50    84  -414
>>right = B*dot(A,C)-C*dot(A,B)
 right =
     450    84  -414
```

So the left and right sides of the equation give identical results.

2.44 Note that we must express the vectors as three-dimensional vectors in order to use the cross-product. The session is

```
>>A = [5, 0, 0]; B = [1, 3, 0];
>>C = cross(A,B);
>>area = sqrt(C*C')
area =
   15
```

The area is 15. If w had known that C has only one component (C = [0, 0, 15]), we would not have needed to use the line area = sqrt(C*C')} to compute the area.

2.45 The session is

```
>>A = [5, 0, 0]; B = [2, 4, 0]; C = [3, 0, -2];
>>D = cross(B,C);
>>E = dot(A,D);
>>volume = abs(E)
 volume =
     40
```

The volume is 40. Note that since the dot product gives a scalar result, we can use the abs function to compute the magnitude of $|\mathbf{A}\cdot(\mathbf{B}\times\mathbf{C}|$.

2.46 The session is

```
>>p1 = [3,-6,8,4,90];
>>p2 = [3, 5, -8, 70];
>>x = [-3:0.01:3];
>>y = polyval(p1,x);
>>z = polyval(p2,x);
>>plot(x,y,x,z,'--'),xlabel('x'),…
      ylabel('y and z'),gtext('y'),gtext('z')
```

2.47 The session is

```
>>p = [3,-5,-28,-5,200];
>>x = [-1:0.01:1];
>>y = polyval(p,x);
>>plot(x,y,),xlabel('x'),ylabel('y'),grid,[x,y] = ginput(1)
```

The values returned at the peak are x = -0.0970 and y = 200.2190. These values are approximate because they depend on the placement of the cursor and the size of the plot. The exact value for the peak can be determined with calculus. It occurs at $x = -0.0917$.

2.48 The session is

```
>>conv([10,-9,-6,12],[5,-4,-12,8])
ans
     50     -85    -114     272     -48    -192      96
```

The answer is $50x^6 - 85x^5 - 114x^4 + 272x^3 - 48x^2 - 192x + 96$.

2.49 The session is

```
>>[q,r] = deconv([14,-6,3,9],[5,7,-4])
 q =
     2.8000    -5.1200
 r =
     0.0000     0.0000     50.0400    -11.4800
```

The answer is $2.8x-5.12$ with a remainder of $50.04x-11.48$.

2.50 Using the deconv command, the session is

```
>>p1 = [24,-9,0,-7]; p2 = [10,5,-3,-7];
>>[q,r] = deconv(p1,p2);
>>ratio = polyval(q,5)+polyval(r,5)/polyval(p2,5)
 ratio =
      2.0458
```

2.51 Solving the ideal gas law for $\hat{V}$ gives $\hat{V} = RT / P$. To solve the van der Waals equation for $\hat{V}$, multiply both sides by $\hat{V}$ to obtain

$$P\hat{V}^2(\hat{V} - b) = RT\hat{V}^2 - a(\hat{V} - b)$$

Collect terms to obtain a cubic equation for $\hat{V}$:

$$P\hat{V}^3 - (Pb + RT)\hat{V}^2 + a\hat{V} - ab = 0$$

The script file is:

```
P = 0.95;T = 300;R = 0.08206;a = 6.49;b = 0.0562;
ideal = R*T/P
Waals = roots([P,-(P*b + R*T),a,-a*b])
```

The answer for the ideal gas law is $\hat{V} = 25.9137$. For the van der Waals model, $\hat{V} = 25.7047$ (the other two roots are close to zero and are not physically significant).

2.52 a) The location of aircraft A is given by $x_A = 320t - 800$. The location of aircraft B is given by $y_B = -160t + 410$. The distance between them is given by $D = \sqrt{x_A^2 + y_B^2}$. We can use the conv function to obtain x_A^2 and y_B^2 as shown in the following session.

```
>>yB = [-160,410]; xA = [320, -800];
>>D2 = conv(xA,xA) + conv(yB,yB)
 D2 =
     128000       -643200        808100
```

Thus

$$D = \sqrt{128{,}000t^2 - 643{,}200t + 808{,}100}$$

Continue the session as follows:

```
>>t = [2:0.005:3];
>>D = sqrt(polyval(D2,t));
>>plot(t,D),xlabel('t'),ylabel('D'),grid,[x,y] = ginput(1)
```

The minimum distance determined from the graph is about $D = 8.5$ mi at about $t = 2.51$ hr after 1:00 P.M.

b) For $D = 30$, we must solve the equation

$$S = x_A^2 + y_B^2 - D^2 = x_A^2 + y_B^2 - 900 = 0$$

This is a second-order polynomial equation in the variable t. Continue the previous session as follows.

```
>>S = conv(xA,xA) + conv(yB,yB) - [0,0,900];
>>roots(S)
ans
     2.5925
     2.4325
```

The solutions are $t = 2.5925$ hr and $t = 2.4325$ hr after 1:00 P.M. At these two times the aircraft are 30 mi from each other.

2.53 The script file is

```
num = [3, -12, 20];
den = [1, -7, 10];
dt = 0.03;
x1 = [0:0.01:2-dt];
x2 = [2+dt:0.01:5-dt];
x3 = [5+dt:0.01:7];
y1 = polyval(num,x1)./polyval(den,x1);
y2 = polyval(num,x2)./polyval(den,x2);
y3 = polyval(num,x3)./polyval(den,x3);
plot(x1,y1,x2,y2,x3,y3),xlabel('x'),ylabel('y')
```

The range of y is determined by the value of dt. A small value of dt gives a large range for y, which makes the shape of the plot difficult to distinguish. Other choices besides dt = 0.03 will work. The plot is shown in the figure.

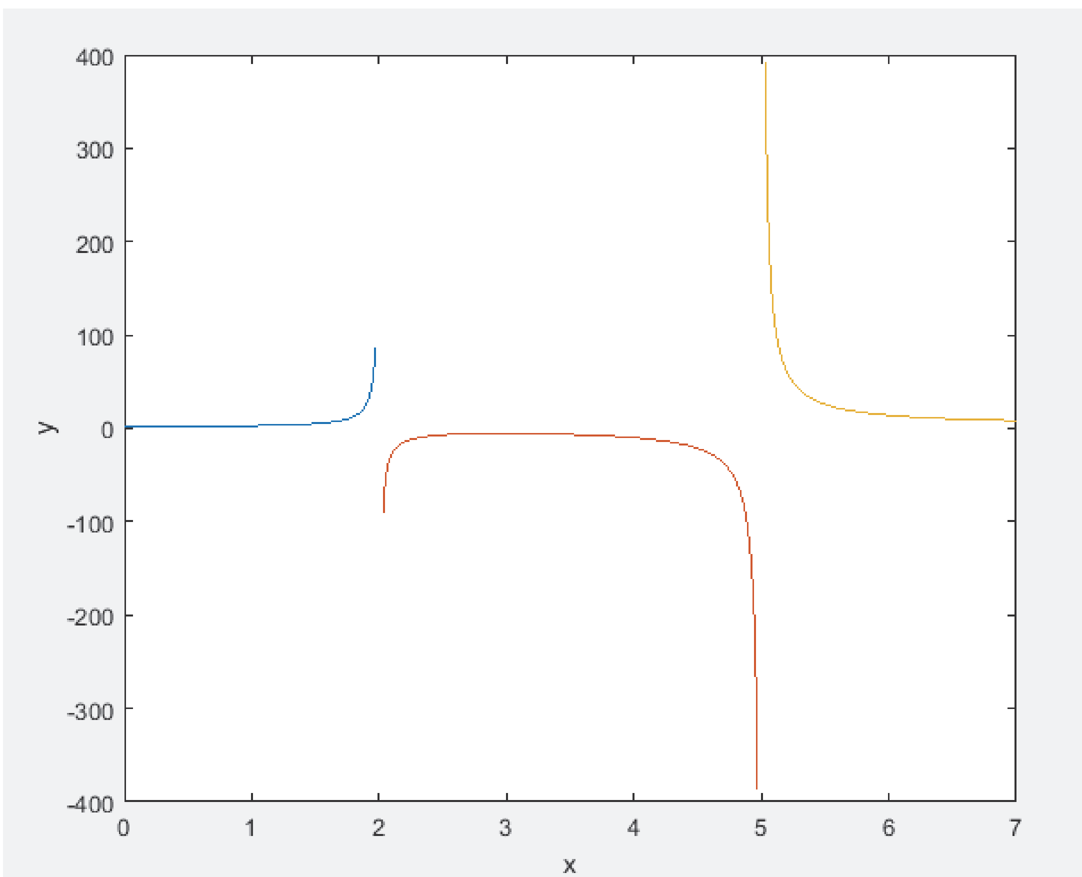

Figure for Problem 2.53

2.54 The script file is:

```
rho = 0.002378;S = 36;alpha=10;
V=[0:0.5:150]*(5280/3600);
CL = [4.47e-5,1.15e-3,6.66e-2,0.102];
CD = [5.75e-6,5.09e-4,1.81e-4,1.25e-2];
L = 0.5*rho*S*polyval(CL,alpha).*V.^2;
D = 0.5*rho*S*polyval(CD,alpha).*V.^2;
plot(V*(3600/5280),L,V*(3600/5280),D,'--'),...
title('Lift and Drag Versus Speed for \alpha = 10^o'),...
xlabel('Speed (miles/hour)'),ylabel('L, D (pounds)'),gtext('L'),gtext('D')
```

The plot is shown in the figure.

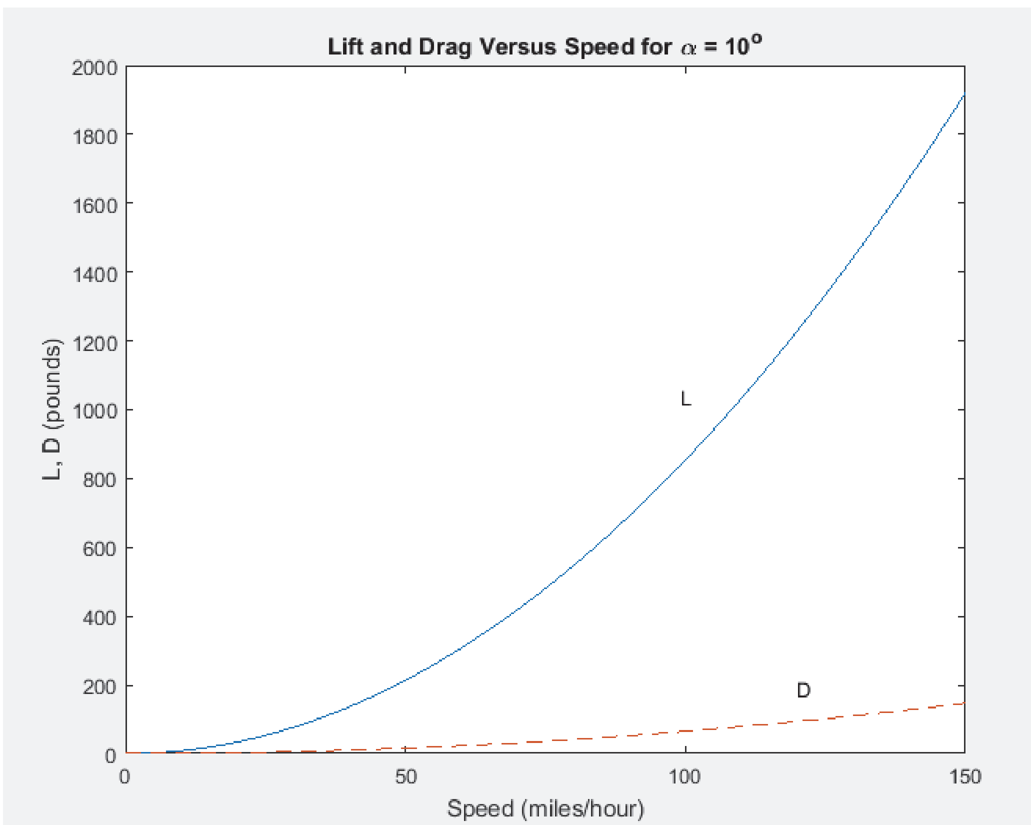

Figure for Problem 2.54

2.55 The script file is

```
rho = 0.002378;S = 36;
alpha = [-2:0.01:22];
CL = [4.47e-5,1.15e-3,6.66e-2,0.102];
CD = [5.75e-6,5.09e-4,1.81e-4,1.25e-2];
LoverD = polyval(CL,alpha)./polyval(CD,alpha);
plot(alpha,LoverD),xlabel('Angle of Attack \alpha (degrees)'),...
ylabel('Lift/Drag (dimensionless)')
```

The plot is shown in the figure.

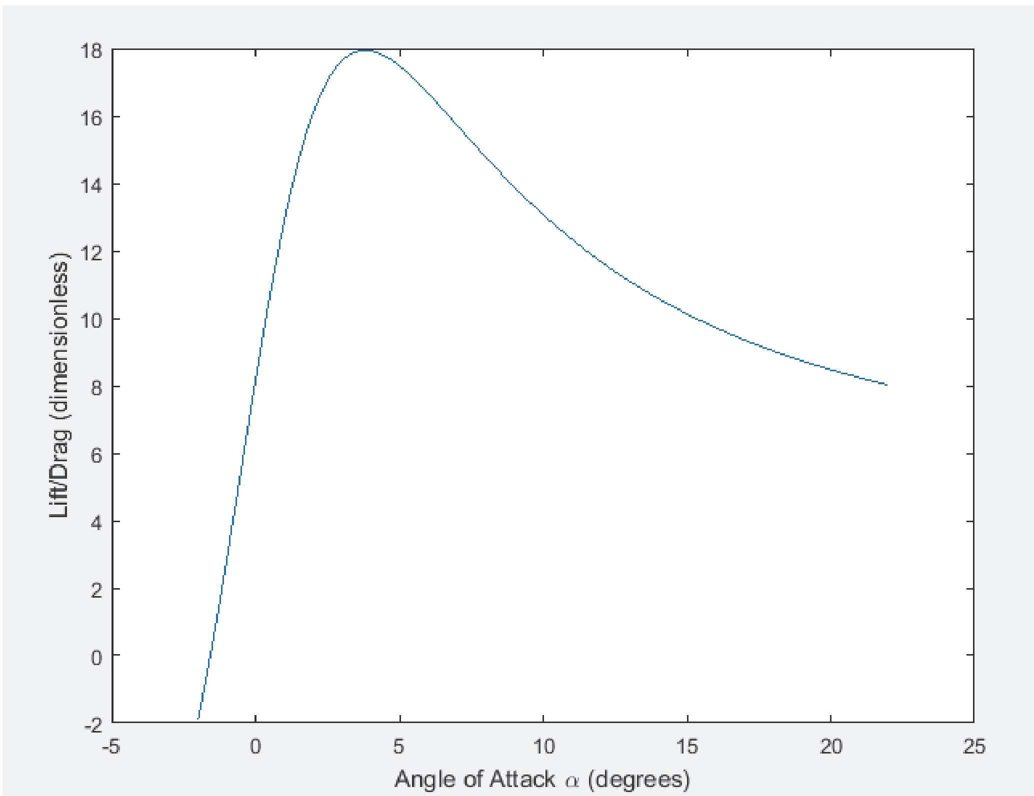

Figure for Problem 2.55

2.56 The script is

```
% Part a
v0 = 100;
A = 35;
g = 9.81;
t_hit = 2*v0*sind(A)/g
d = t_hit/1000;
t = [0:d:t_hit];
x = (v0*cosd(A))*t;
y = (v0*sind(A))*t-0.5*9.81*t.^2;
plot(x,y),xlabel('x (m)'),ylabel('y (m)')
% Part b
yd=100;
td=roots([g/2,-v0*sind(A),yd])
yd=200;
td=roots([g/2,-v0*sind(A),yd])
```

Answers. a. t_hit =11.6937 s.

b. For y_d = 100, t_d = 9.5615,2.1322. At t = 2.1322 s, the projectile passes 100 m going up At t = 9.5615 s, the projectile passes 100 m going down. See the figure below.

For y_d = 2100, $t_d = 5.8469 \pm 2.5669i$. These are complex because the projectile never reaches 200 m, as shown by the figure below.

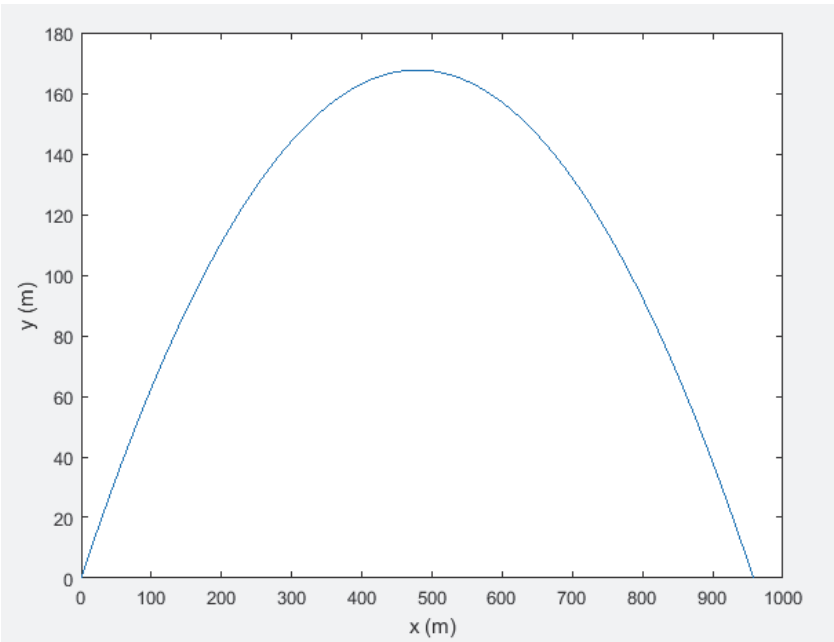

Figure for Problem 2.56

2.57 The script file is

```
% Using cell indexing:
A(1,1) = {'Motor 28C'};
A(1,2) = {'Test ID 6'};
A(2,1) = {[3,9;7,2]};
A(2,2) = {[6,5,1]};
% Using content indexing:
B{1,1} = 'Motor 28C';
B{1,2} = 'Test ID 6';
B{2,1} = [3,9;7,2];
B{2,2} = [6,5,1];
disp(B{2,1}(1,1))
```

When this file is run, it displays the answer 3.

2.58 Here we create a three dimensional cell array. The three layers correspond to the values $L=1$, 2, and 3 respectively. Some combinations of r and d values result in negative or infinite values for the capacitance C, and thus are invalid cases. The script file is

```
epsilon = 8.854e-12;
r1 = .001*[1,2,3]; r = [r1',r1',r1',r1'];
d1 = .001*[3,4,5,10];  d=[d1;d1;d1];
L = 1;
C{1,1,1} = 'L = 1';
C{1,2,1} = 'd';
C{2,1,1} = 'r';
C{2,2,1} = pi*epsilon*L./log((d-r)./r);
 L = 2;
C{1,1,2} = 'L = 2';
C{1,2,2} = 'd';
C{2,1,2} = 'r';
C{2,2,2} = pi*epsilon*L./log((d-r)./r);
L = 3;
C{1,1,3} = 'L = 3';
C{1,2,3} = 'd';
C{2,1,3} = 'r';
C{2,2,3} = pi*epsilon*L./log((d-r)./r);
C{2,2,2}(1,3)
```

The structure of the array C can be seen by typing C. For the first layer you will see displayed:

```
C(:,:,1) =
     ' L = 1 '      'd'
     'r'      [3x4 double]
```

The other two layers have a similar structure. To see the entire array, type celldisp(C).

The capacitance values are in the (2,2) cell in each layer. The values for $L=2$ are in the second layer (because $L=2$ is the second value of L). The capacitance value C_{ij} corresponds to the values r_i and d_j. Thus the values for $r=0.001$ and $d=0.005$ are in the $(1,3)$ element of the array in cell (2,2) (because $r=0.001$ is the first value of r and $d=0.005$ is the third value of d). The capacitance value is 4.013×10^{-11}.

2.59 (a) One slug is the same as 14.594 kg. One pound is the same as 4.4482 N. One foot is the same as 0.3048 meter. The script file is named convert.m and is

```
%Convert slugs to kg
convert(1).mass = 14.594;
%Convert kg to slugs
convert(2).mass = 1/convert(1).mass;
%Convert lbs to newtons
convert(1).force = 4.4482;
%Convert newtons to lbs
convert(2).force = 1/convert(1).force;
%Convert feet to meters
convert(1).length = .3048;
%Convert meters to feet
convert(2).length = 1/convert(1).length;
```

(b) The session is

```
>>convert(1).length*48
ans
     14.6304
>>convert(2).length*130
ans
     426.5092
>>convert(2).force*36
ans
     8.0932
>>convert(1).force*10
ans
     44.4820
>>convert(1).mass*12
ans
     175.1280
>>convert(2).mass*30
ans
     2.0556
```

2.60 The script file is

```
bridge(1).location = 'Smith St';
bridge(1).maxload = 80;
bridge(1).yearbuilt = 1928;
bridge(1).duemaint = 2011;
bridge(2).location = 'Hope Ave';
bridge(2).maxload = 90;
bridge(2).yearbuilt = 1950;
bridge(2).duemaint = 2013;
bridge(3).location = 'Clark St';
bridge(3).maxload = 85;
bridge(3).yearbuilt = 1933;
bridge(3).duemaint = 2012;
bridge(4).location = 'North Rd';
bridge(4).maxload = 85;
bridge(4).yearbuilt = 1960;
bridge(4).duemaint = 2012;
```

2.61 The session is

```
>>bridge(3).duemaint = 2018;
```

2.62 The session is

```
>>bridge(5).location = 'Shore Rd';
>>bridge(5).maxload = 85;
>>bridge(5).yearbuilt = 1997;
>>bridge(5).duemaint = 2014;
```