Solutions Manual©

to accompany

MATLAB for Engineering Applications, Fourth Edition

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Solutions to Problems in Chapter One

Test Your Understanding Problems

T1.1-1 Depending on what toolboxes you have installed, you should see something like

MATLAB	Version 9.2	(R2017a Release)
Simulink	Version 8.9	(R2017a Release)
Control System Toolbox	Version 10.2	(R2017a Release)
Symbolic Math Toolbox	Version 7.2	(R2017a Release)

T1.1-2 a) `6*10/13 + 18/(5*7) + 5*9^2.` Answer is 410.1297.

b) `6*35^(1/4) + 14^0.35`. Answer is 17.1123.

T1.1-3 Type the expressions given in the problem to obtain a) 0.04 b) 0.02 c) 0.2 d) 32.

T1.1-4

```
x = -5 + 9i; y = 6 - 2i;
S = x + y
P = x*y
R = x/y
```

T1.3-1 The session is:

```
>>x = cos(0):0.02:log10(100);
>>length(x)
ans =
      51
>>x(25)
ans =
      1.4800
```

T1.3-2 The session is:

```
>>roots([1, 6, -11, 290]
ans =
      -10.000
      2.0000 + 5.0000i
      2.0000 - 5.0000i
```

The roots are −10 and 2 ± 5i.

T1.3-3 The script is:

```
x = 0:0.01:10;
y = 3*x.^2 + 2;
plot(x,y), xlabel('x'),ylabel('y')
```

T1.3-4 The session is:

```
>>t = 0:0.01:5;
>>s = 2*sin(3*t+2) + sqrt(5*t+1);
>>plot(t,s),xlabel('Time (sec)'),ylabel('Speed (ft/sec)')
```

T1.3-4 The session is:

```
>>x = 0:0.01:1.5;
>>y = 4*sqrt(6*x+1);
>>z = 5*exp(0.3*x)-2*x;
>>plot(x,y,x,z,'–'O),xlabel('Distance (m)'),ylabel('Force (N)')
```

T1.3-5 The session is:

```
>>x = 0:0.01:1.5;
>>y = 4*sqrt(6*x+1);
>>z = 5*exp(0.3*x)-2*x;
>>plot(x,y,x,z,'- -'),xlabel('Distance (m)'),ylabel('Force (N)')
```

T1.4-1 The script is:

```
r = input('Enter the sphere radius:');
A = 4*pi*r^2;
disp('The surface area is:')
disp(A)
```

T1.4-2 The script is:

```
a = input('Enter a: ')
b = input('Enter b: ')
c = sqrt(a^2+b^2)
```

T1.5-1 Typing help nthroot returns:

"nthroot(X, N) returns the real Nth root of the elements of X."

"Both X and N must be real, and if X is negative, N must be an odd integer."

T1.5-2 Typing lookfor hyperbolic returns 12 functions.

T1.5-3 Typing “help why” returns:

“ why Provides succinct answers to almost any question.”

“ why, by itself, provides a random answer.”

“why(N) provides the N-th answer.”

“ Please embellish or modify this function to suit your own tastes.”

End-of-Chapter Problems

1.1. The session is:

```
>>x = 10; y = 3;
>>u = x + y
u =
      13
>>v = x*y
v =
      30
>>w = x/y
w =
      3.3333
>>z = sin(x)
z =
      -0.5440
>>r = 8*sin(y)
r =
      1.1290
>>s = 5*sin(2*y)
s =
      -1.3971
```

1.2. The session is:

```
>>y*x^3/(x-y)
ans =
     -13.3333
>>3*x/(2*y)
ans =
     0.6000
>>3*x*y/2
ans =
     15
>>x^5/(x^5-1)
ans =
     1.0323
```

1.3. The session is:

```
>>x = 3; y = 4;
>>1/(1-1/x^5)
ans =
      1.0041
>>3*pi*x^2
ans =
      84.8230
>>3*y/(4*x-8)
ans =
      3
>>4*(y-5)/(3*x-6)
ans =
      -1.3333
```

1.4. a) `x = 3;y = 6*x^3 + 4/x`. The answer is $y = 163.3333$.

b) `x = 7;y = (x/4)*3`. The answer is $y = 5.2500$.

c) `x = 9;y = (4*x)^2/25`. The answer is $y = 51.8400$.

d) `x = 4;y = 2*sin(x)/5`. The answer is $y = -0.3027$.

e) `x = 30;y = 7*x^(1/3) + 4*x^0.58`. The answer is $y = 50.5107$.

1.5. The session is:

```
>>a = 1.12; b = 2.34; c = 0.72;d = 0.81;f = 19.83;
>>x = 1 + a/b + c/f^2
x =
      1.4805
>>s = (b-a)/(d-c)
s =
      13.5556
>>r = 1/(1/a + 1/b + 1/c + 1/d)
r =
      0.2536
>>y = a*b/c*f^2/2
y =
      715.6766
```

1.6. The session is:

```
>>a = (3/4)*6*7^2+4^5/(7^3-145);
>>b = (48.2*55-9^3)/(53+14^2);
>>c = 27^2/4+319^(4/5)/5+60*14^-3;
```

The answers are: a = 225.6717, b = 7.7189, and c = 202.4120.

1.7. a) `1/16`, `16^-1`, and `16^(-1)` all give the correct answer: 0.0625.

b) `16^ (-1/2)` gives the correct answer: 0.25. `16^-1/2` is incorrect.

c) `16^(-1/2)` gives the correct answer: 0.25.

d) `64^(3/2)` gives the correct answer: 512. `64^3/2` is incorrect.

1.8. a) 0.01 b) 0.005 c) 0.1 d) 500,000

1.9. a) c=8, overflow b) f = 0, underflow, c) i) x = 8 ii) y = 25, x =7.5 x 10^{151}

1.10. The session is:

```
>>r = 6; h = 10
>>V = pi*r^2*h;
>>V = 1.3*V;
>>r = (V/(pi*h))^(1/2)
      r =  6.8411
```

The required radius is 6.8411.

1.11. The session is:

```
>>r = 4;
>>V = 4*pi*r^3/4;
>>V = 1.4*V;
>>r = ((3*V)/(4*pi))^(1/3)
r =
      4.0656
```

The required radius is 4.958.

1.12. The session is

```
>>x = -7-5i;y = 4+3i;
>>x+y
ans =
      -3.0000 - 2.0000i
>>x*y
ans =
      -13.0000 -41.0000i
>>x/y
ans =
      -1.7200 + 0.0400i
```

1.13. The session is:

```
>>(3+6i)*(-7-9i)
ans =
      33.0000 -69.0000i
>>(5+4i)/(5-4i)
ans =
      0.2195 + 0.9756i
>>3i/2
ans =
      0 + 1.5000i
>>3/2i
ans =
      0 - 1.5000i
```

1.14. The session is:

```
>>x = 5+8i;y = -6+7i;
>>u = x + y;v = x*y;
>>w = x/y;z = exp(x)
>>r = sqrt(y);s = x*y^2;
```

The answers are u = −1+15i, $v = -86-13i$, w = 0.3059−0.9765i, $z = -21.594+146.83i$, $r = 1.2688 + 2.7586i$, and s = 607 − 524i.

1.15. The session is:

```
>>n = 1;R = 0.08206;T = 273.2;V=22.41;
>>a = 6.49;b = 0.0562;
>>Pideal = n*R*T/V
Pideal =
      1.0004
>>P1 = n*R*T/(V - nb)
P1 =
      1.0029
>>P2 = (a*n^2)/V^2
P2 =
      0.0129
>>Pwaals = P1 + P2
Pwaals =
      1.0158
```

The ideal gas law predicts a pressure of 1.0004 atmospheres, while the van der Waals model predicts 1.0158 atmospheres. Most of the difference is due to the P2 term, which models the molecular attractions.

1.16. The ideal gas law gives

$$\frac{T}{V} = \frac{P}{nR} = constant$$

Thus $T_1 / V_1 = T_2 / V_2$ or $V_2 = V_1 T_2 / T_1$. The session is:

```
>>V1 = 28500;T1 = 273.2 - 15;T2 = 273.2 + 31;
>>V2 = V1*T2/T1
       V2 = 3.3577e+4
```

The volume is 33,577 cubic feet.

1.17. a) exp(2) gives 7.3891.

b) log10(2) gives 0.3010.

c) log(2) gives 0.6931. ln(2) gives "Undefined function or variable 'ln'."

d) 600^(1/4) gives the correct answer: 4.9492. 600^1/4 gives 150, which is incorrect.

1.18. a) cos(pi/2) gives 6.1232e-17.

b) cosd(80) gives 0.1736.

c) acos(0.7) gives 0.7954.

1.19. a) atan(2) gives 1.1071.

b) atand(100) gives 89.4271.

c) atan2d(3,2) gives 56.3099 degrees.

d) atan2d(3,-2) gives 123.6901 degrees.

e) atan2d(-3,2) gives $-$56.3099 degrees.

d) acosd(0.6) gives 53.1301.

1.20. The session is:

```
>>x=1:0.2:5;
>>y = 7*sin(4*x);
>>length(y)
ans =
     21
>>y(3)
ans =
     -4.4189
```

There are 21 elements. The third element is −4.4189.

1.21. The session is:

```
>>x = sin(-pi/2):0.05:cos(0);
>>length(x)
ans =
      41
>>x(10)
ans =
      -0.5500
```

There are 41 elements. The tenth element is 0.55.

1.22. The session is:

```
>>a = exp(-2.1^3)+3.47*log10(14)+(287)^(1/4);
>>b = 3.4^7*log10(14)+(287)^(1/4);
>>c = (cos(4.12*pi/6))^2;
>>d = cos((4.12*pi/6)^2);
```

The answers are a = 8.0931, b = 6.0240 × 103, c = 0.3062, and d = −0.0587.

1.23. The session is:

```
>>a = 6*pi*atan(12.5)+4;
>>b = 5*tan(3*asin(13/5));
>>c = 5*log(7);
>>d = 5*log10(7);
```

The results are a = 32.1041, b = 0.0000 − 5.0006i, c = 9.7296, and d = 4.2255. In part (b) note that complex results are obtained from asin(x) if |x| > 1 and from tan(x) if x is complex.

1.24. The session is:

```
>>ratio=10^(1.5*7.6)/10^(1.5*5.6)
```

The answer is ratio = 1000, or 1000 times more energy.

1.25. The session is:

```
>>p = ([13,182,-184,2503];
>>r = roots(p)
r =
      -15.6850
      0.8425 + 3.4008i
      0.8425 - 3.4008i
```

The roots are x = −15.685 and x = 0.8425 ± 3.4008i.

1.26. The session is:

```
>>p = [70, 24, -10, 20];
>>roots(p)
ans =
      -0.8771
      0.2671 + 0.5044i
      0.2671 - 0.5044i
```

The roots are −0.8771 and 0.2671 ± 0.5044i.

1.27. The session is:

```
>>t = 1:0.005:3;
>>T = 6*log(t) - 7*exp(-0.2*t);
>>plot(t,T),title('Temperature Versus Time'),...
      xlabel('Time t (min)'),ylabel('Temperature T ^\circ C)')
```

1.28. The session is:

```
>>x = 0:0.01:2;
>>u = 2*log10(60*x+1);
>>v = 3*cos(6*x);
>>plot(x,u,x,v,0--0),ylabel('Speed (mi/hr)'),xlabel('Distance x (mi)')
```

1.29. The session is

```
>>x1 = [0,pi];
>>x2 = [-pi,0];
>>x = -pi:0.01:pi;
>>f1 = [1,1];
>>f2 = -[1,1];
>>series =
(4/pi)*(sin(x)+(1/3)*sin(3*x)+(1/5)*sin(5*x)+(1/7)*sin(7*x));
>>plot(x,series,x1,f1,x2,f2),xlabel('x')
```

The plot is shown in the figure.

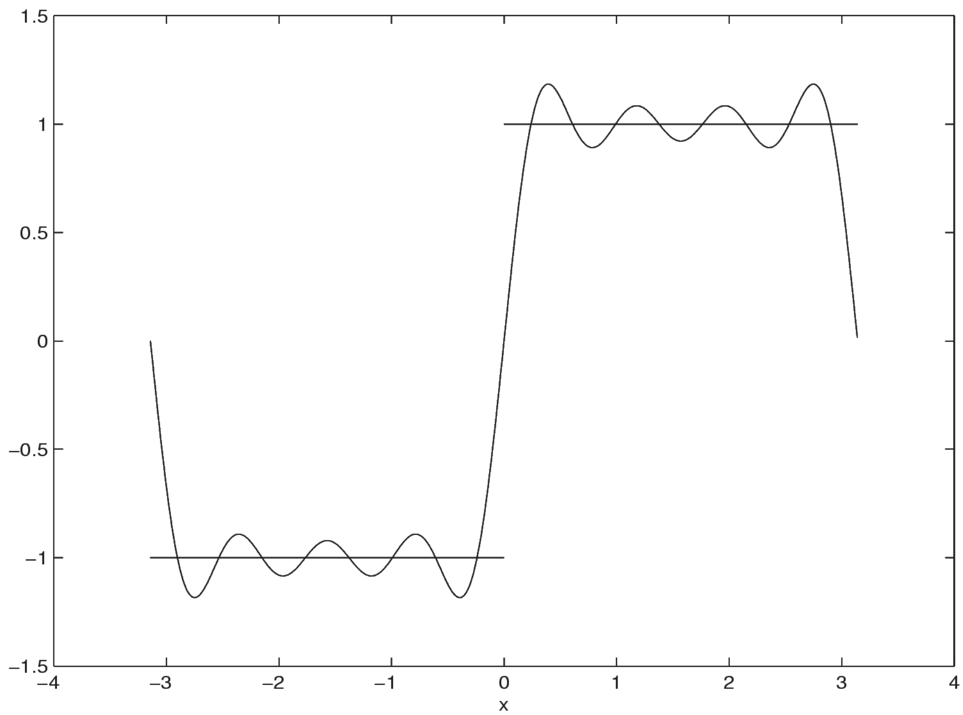

Figure for Problem 1.29

1.30. The session is

```
>>r = 10;
>>phi = 0:0.01:4*pi;
>>x = r*(phi-sin(phi));
>>y = r*(1-cos(phi));
>>plot(x,y),xlabel('x'),ylabel('y')
```

The plot is shown in the figure.

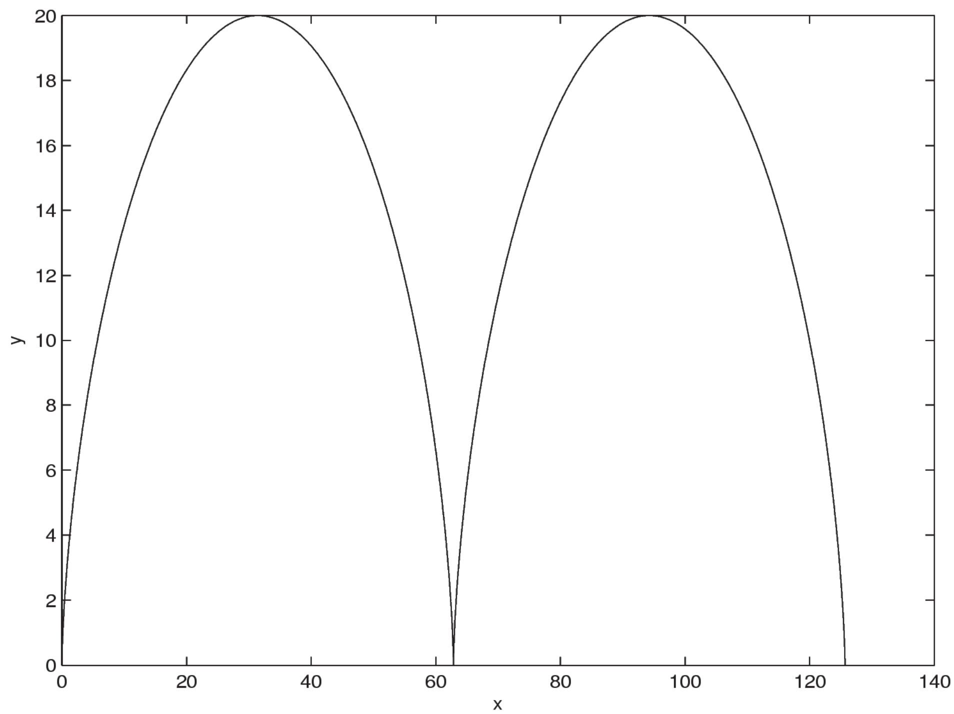

Figure for Problem 1.30

1.31. The script is

```
v=20; % speed(km/hr)
T=3; % total time (hr)
phi =  atan(11/15); % course angle (rad)
t = 0:0.005:T; % time variable
x = -10 + (v*cos(phi))*t; % x variable
y = (11/15)*x + 43/3; % y variable
theta = atan2d(y,x); % bearing angle
plot(t,theta), xlabel('t (hr)'),ylabel('theta (deg)')
```

1.32. The answer depends on the user's computer system.

1.33. Note that

$$W^2 = D^2 + D^2 = 2D^2$$

Thus $D = W/\sqrt{2}$. The area is given by

$$A = WL + \frac{D^2}{2} = WL + \frac{W^2}{4}$$

which can be solved for L:

$$L = \frac{A - \frac{W^2}{4}}{W}$$

The perimeter is given by

$$P = 2L + W + 2\frac{W}{\sqrt{2}}$$

The script file is:

```
W = 6; A = 80;
L = (A - W^2/4)/W
P = 2*L + W + 2*W/sqrt(2)
```

The answers are L = 11.8333 meters and the total length is the perimeter P = 38.1519 meters.

1.34. Applying the law of cosines to the two triangles gives

$$a^2 = b_1^2 + c_1^2 - 2b_1c_1 \cos A_1$$

$$a^2 = b_2^2 + c_2^2 - 2b_2c_2 \cos A_2$$

With the given values we can solve the first equation for a_1, then solve the second equation for c_2. The second equation is a quadratic in c_2, and can be written as

$$c_2^2 - (2b_2 \cos A_2)c_2 + b_2^2 - a^2 = 0$$

The script file is:

```
b1 = 180;b2 = 165;c1 = 115;
A1 = 120*pi/180;A2 = 100*pi/180;
a = sqrt(b1^2 + c1^2 - 2*b1*c1*cos(A1));
roots([1,-2*b2*cos(A2),b2^2-a^2])
```

The two roots are $c_2 = -228$ and $c_2 = 171$. Taking the positive root gives $c_2 = 171$ meters.

1.35. The script is

```
disp('To compute the roots of x^3+ax^2+bx+c=0, enter a, b, and c.')
a = input('Enter a: ');
b = input('Enter b: ');
c = input('Enter c: ');
roots([1,a,b,c])
```

For example, if a= 23, b = 4, and c = 5, the roots are

-22.8344 + 0.0000i

-0.0828 + 0.4606i

-0.0828 - 0.4606i

1.36. Typing “help plot” gives the required information. Typing “help label” obtains the response “label not found”. In this case we need to be more specific, such as by typing “help xlabel”, because label is not a command or function, or we can type “lookfor label”.

Similarly, typing “help cos” gives the required information, but typing “help cosine” obtains the response “cosine not found”. Typing “lookfor cosine” directs you to the cos command. Typing “help :” and “help *” gives the required information.

1.37. Typing “help sqrt” produces the response “sqrt(X) is the square root of the elements of X. Complex results are produced if X is not positive.”

It is suggested to investigate realsqrt(X), which gives the square root of the elements of X. An error is produced if X is negative.

1.38. Typing “help exp” gives the response “exp(X) is the exponential of the elements of X, e to the X. For complex Z=X+i*Y, exp(Z) = exp(X)*(COS(Y)+i*SIN(Y))”.

From Euler’s identity, if $z = x + iy$, $e^z = e^x (\cos y + i \sin y)$.

1.39. (a) If we neglect drag, then conservation of mechanical energy states that the kinetic energy at the time the ball is thrown must equal the potential energy when the ball reaches the maximum height. Thus

$$\frac{1}{2}mv^2 = mgh$$

where v is the initial speed and h is the maximum height. We can solve this for v:

$$v = \sqrt{2gh}$$

Note that the mass m cancels, so the result is independent of m.

For h = 20 feet, we get

$$v = \sqrt{2(32.2)(20)} = 35.9\,ft/sec$$

Because speed measured in miles per hour is more familiar to most of us, we can convert the answer to miles per hour as a "reality check" on the answer. The result is v = 35.9(3600)/5280 = 24.5 miles per hour, which seems reasonable.

(b) The issues here are the manner in which the rod is thrown and the effect of drag on the rod. If the drag is negligible and if we give the mass center a speed of 35.9 feet/second, then the mass center of the rod will reach a height of 20 feet. However, if we give the rod the same kinetic energy, but throw it upward by grasping one end of the rod, then it will spin and not reach 20 feet. The kinetic energy of the rod is given by

$$KE = \frac{1}{2}mv_{mc}^2 + \frac{1}{2}I\omega^2$$

where v_{mc} is the speed of the rod's mass center. For the same rotational speed and kinetic energy, a rod with a larger inertia I will reach a smaller height, because a larger fraction of its energy is contained in the spinning motion. The inertia I increases with the length and radius of the rod. In addition, a longer rod will have increased drag, and will thus reach a height smaller than that predicted using conservation of mechanical energy.

1.40. (a) When A = 0, d = $L_1 + L_2$. When A = 180, d = $L_1 - L_2$. The stroke is the difference between these two values. Thus the stroke is $L_1 + L_2 - (L_1 - L_2) = 2L_2$ and depends only on L_2.

b) The MATLAB session looks like the one shown in the text, except that $L_1 = 0.6$ is used for the first plot and $L_1 = 1.4$ for the second plot . The plots are shown in the following two figures. Their general shape is similar, but they are translated vertically relative to one another.

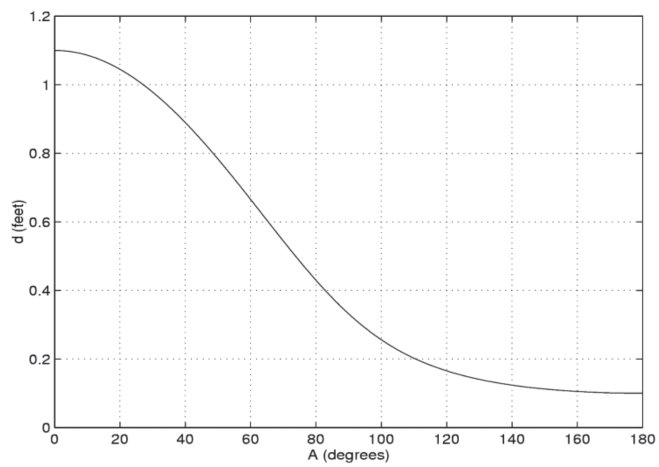

Figure for Problem 1.40

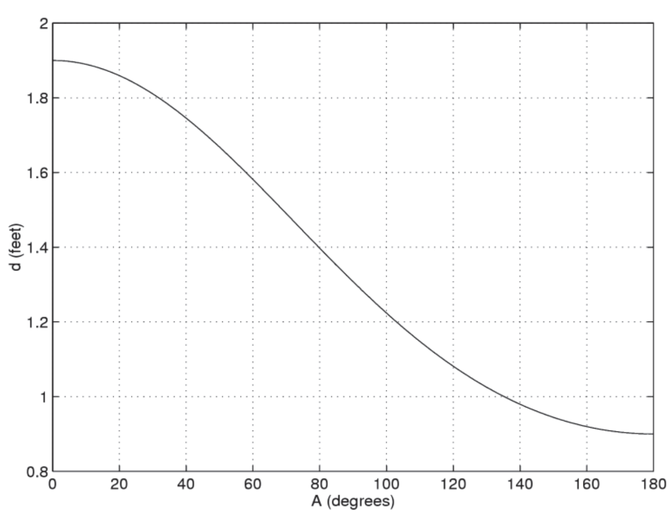

Figure for Problem 1.40