ME 1020 Engineering Programming with MATLAB

Chapter 2 Homework Solutions: 2.2, 2.5, 2.9, 2.12, 2.17, 2.24, 2.31, 2.33, 2.35, 2.43

Problem 2.2:

2. *a*. Create the vector **x** having 50 logarithmically spaced values starting at 10 and ending at 1000.
b. Create the vector **x** having 20 logarithmically spaced values starting at 10 and ending at 1000.

```
% Problem 2.2
disp('Problem 2.2: Scott Thomas')
% Part (a)
disp('Part (a)')
start1=1;
stop1=3;
step1=50;
x1=logspace(start1,stop1,step1)
% Part (b)
disp('Part (b)')
start2=1;
stop2=3;
step2=20;
x2=logspace(start2,stop2,step2)
```

```
Problem 2.2: Scott Thomas
Part (a)

x1 =

   1.0e+03 *

  Columns 1 through 7

    0.0100    0.0110    0.0121    0.0133    0.0146    0.0160    0.0176

  Columns 8 through 14

    0.0193    0.0212    0.0233    0.0256    0.0281    0.0309    0.0339

  Columns 15 through 21

    0.0373    0.0409    0.0450    0.0494    0.0543    0.0596    0.0655

  Columns 22 through 28

    0.0720    0.0791    0.0869    0.0954    0.1048    0.1151    0.1265

  Columns 29 through 35

    0.1389    0.1526    0.1677    0.1842    0.2024    0.2223    0.2442

  Columns 36 through 42
```

```
    0.2683    0.2947    0.3237    0.3556    0.3907    0.4292    0.4715

  Columns 43 through 49

    0.5179    0.5690    0.6251    0.6866    0.7543    0.8286    0.9103

  Column 50

    1.0000
```

Part (b)

```
x2 =

   1.0e+03 *

  Columns 1 through 7

    0.0100    0.0127    0.0162    0.0207    0.0264    0.0336    0.0428

  Columns 8 through 14

    0.0546    0.0695    0.0886    0.1129    0.1438    0.1833    0.2336

  Columns 15 through 20

    0.2976    0.3793    0.4833    0.6158    0.7848    1.0000
```

Problem 2.5:

5. Type this matrix in MATLAB and use MATLAB to carry out the following instructions.

$$\mathbf{A} = \begin{bmatrix} 3 & 7 & -4 & 12 \\ -5 & 9 & 10 & 2 \\ 6 & 13 & 8 & 11 \\ 15 & 5 & 4 & 1 \end{bmatrix}$$

a. Create a vector **v** consisting of the elements in the second column of **A**.
b. Create a vector **w** consisting of the elements in the second row of **A**.

```
% Problem 2.5
disp('Problem 2.5: Scott Thomas')
A =[3 7 -4 12; -5 9 10 2; 6 13 8 11; 15 5 4 1]
% Part (a)
disp('Part (a)')
v=A(:,2)

% Part (b)
disp('Part (b)')
w=A(2,:)
```

```
Problem 2.5: Scott Thomas

A =

     3     7    -4    12
    -5     9    10     2
     6    13     8    11
    15     5     4     1

Part (a)

v =

     7
     9
    13
     5

Part (b)

w =

    -5     9    10     2
```

Problem 2.9:

9. Given the matrix

$$\mathbf{A} = \begin{bmatrix} 3 & 7 & -4 & 12 \\ -5 & 9 & 10 & 2 \\ 6 & 13 & 8 & 11 \\ 15 & 5 & 4 & 1 \end{bmatrix}$$

a. Sort each column and store the result in an array **B**.
b. Sort each row and store the result in an array **C**.
c. Add each column and store the result in an array **D**.
d. Add each row and store the result in an array **E**.

```
% Problem 2.9
disp('Problem 2.9: Scott Thomas')
A =[3 7 -4 12; -5 9 10 2; 6 13 8 11; 15 5 4 1]

% Part (a)
disp('Part (a): Sort each column, store result in B')
B=sort(A)

% Part (b)
disp('Part (b): Sort each row, store result in C')
Atranspose=A'
C=sort(Atranspose)

% Part (c)
disp('Part (c): Add each column, store result in D')
D=sum(A)

% Part (d)
disp('Part (d): Add each row, store result in E')
E=sum(Atranspose)
```

```
Problem 2.9: Scott Thomas

A =

     3     7    -4    12
    -5     9    10     2
     6    13     8    11
    15     5     4     1

Part (a): Sort each column, store result in B

B =

    -5     5    -4     1
     3     7     4     2
     6     9     8    11
    15    13    10    12
```

```
Part (b): Sort each row, store result in C

Atranspose =

     3    -5     6    15
     7     9    13     5
    -4    10     8     4
    12     2    11     1


C =

    -4    -5     6     1
     3     2     8     4
     7     9    11     5
    12    10    13    15

Part (c): Add each column, store result in D

D =

    19    34    18    26

Part (d): Add each row, store result in E

E =

    18    16    38    25
```

Problem 2.12:

12.* Given the matrices

$$\mathbf{A} = \begin{bmatrix} -7 & 11 \\ 4 & 9 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 4 & -5 \\ 12 & -2 \end{bmatrix} \qquad \mathbf{C} = \begin{bmatrix} -3 & -9 \\ 7 & 8 \end{bmatrix}$$

Use MATLAB to

a. Find $\mathbf{A} + \mathbf{B} + \mathbf{C}$.

b. Find $\mathbf{A} - \mathbf{B} + \mathbf{C}$.

c. Verify the associative law

$$(\mathbf{A} + \mathbf{B}) + \mathbf{C} = \mathbf{A} + (\mathbf{B} + \mathbf{C})$$

d. Verify the commutative law

$$\mathbf{A} + \mathbf{B} + \mathbf{C} = \mathbf{B} + \mathbf{C} + \mathbf{A} = \mathbf{A} + \mathbf{C} + \mathbf{B}$$

```
% Problem 2.12
clear
clc
disp('Problem 2.12: Scott Thomas')
A = [-7 11; 4 9]
B = [4 -5; 12 -2]
C = [-3 -9; 7 8]

% Part (a)
disp('Part (a): find A + B + C')

D = A + B + C

% Part (b)
disp('Part (b): find A - B + C')

E = A - B + C

% Part (c)
disp('Part (c): verify associative law (A+B)+C = A+(B+C)')

F = A + B
disp('Left-hand side')
G = F + C

H = B + C
disp('Right-hand side')
J = A + H

% Part (d)
disp('Part (d): verify associative law A+B+C = B+C+A = A+C+B')

K=A+B+C
L = B+C+A
M = A+C+B
```

```
% Problem 2.12
clear
clc
disp('Problem 2.12: Scott Thomas')
A = [-7 11; 4 9]
B = [4 -5; 12 -2]
C = [-3 -9; 7 8]

% Part (a)
disp('Part (a): find A + B + C')

D = A + B + C

% Part (b)
disp('Part (b): find A - B + C')

E = A - B + C

% Part (c)
disp('Part (c): verify associative law (A+B)+C = A+(B+C)')
F = A + B
disp('Left-hand side')
G = F + C

H = B + C
disp('Right-hand side')
J = A + H

% Part (d)
disp('Part (d): verify associative law A+B+C = B+C+A = A+C+B')

K=A+B+C
L = B+C+A
M = A+C+B
```

Problem 2.12: Scott Thomas

```
A =

   -7    11
    4     9



B =

    4    -5
   12    -2



C =

   -3    -9
    7     8
```

Part (a): find A + B + C

D =

-6 -3
23 15

Part (b): find A - B + C

E =

-14 7
-1 19

Part (c): verify associative law (A+B)+C = A+(B+C)

F =

-3 6
16 7

Left-hand side

G =

-6 -3
23 15

H =

1 -14
19 6

Right-hand side

J =

-6 -3
23 15

Part (d): verify associative law A+B+C = B+C+A = A+C+B

K =

-6 -3
23 15

L =

-6 -3
23 15

M =

$$\begin{matrix} -6 & -3 \\ 23 & 15 \end{matrix}$$

Problem 2.17:

17. Two divers start at the surface and establish the following coordinate system: x is to the west, y is to the north, and z is down. Diver 1 swims 60 ft east, then 25 ft south, and then dives 30 ft. At the same time, diver 2 dives 20 ft, swims east 30 ft and then south 55 ft.

a. Compute the distance between diver 1 and the starting point.
b. How far in each direction must diver 1 swim to reach diver 2?
c. How far in a straight line must diver 1 swim to reach diver 2?

```
% Problem 2.17
clear
clc
disp('Problem 2.17: Scott Thomas')

diver1 = [-60 -25 30]
diver2 = [-30 -55 20]

% Part (a)
disp('Part (a): distance between diver 1 and the starting point')

dist1 = sqrt(sum(diver1.*diver1))

% Part (b)
disp('Part (b): distance in each direction for diver 1 to reach diver 2')

dist2 = diver2 - diver1

% Part (c)
disp('Part (c): Linear distance between diver 1 and diver 2')

dist3 = sqrt(sum(dist2.*dist2))
```

```
Problem 2.17: Scott Thomas

diver1 =

   -60   -25    30


diver2 =

   -30   -55    20

Part (a): distance between diver 1 and the starting point

dist1 =

   71.5891

Part (b): distance in each direction for diver 1 to reach diver 2

dist2 =
```

```
    30   -30   -10
```

Part (c): Linear distance between diver 1 and diver 2

```
dist3 =

   43.5890
```

Problem 2.24:

24. A cable of length L_c supports a beam of length L_b, so that it is horizontal when the weight W is attached at the beam end. The principles of statics can be used to show that the tension force T in the cable is given by

$$T = \frac{L_b L_c W}{D\sqrt{L_b^2 - D^2}}$$

where D is the distance of the cable attachment point to the beam pivot. See Figure P24.

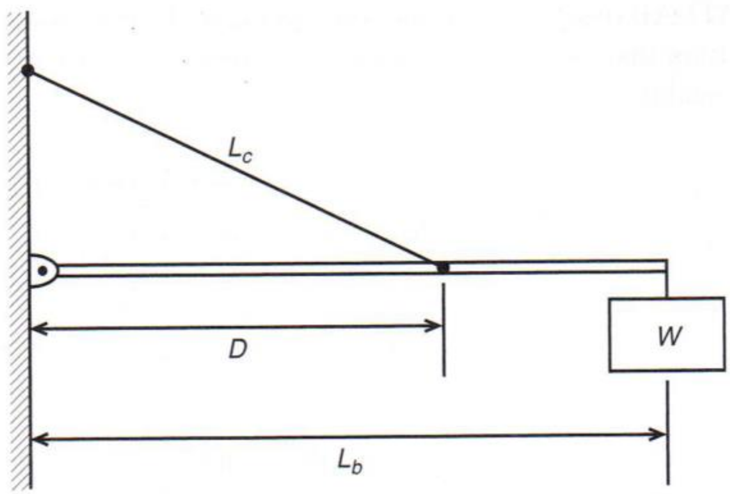


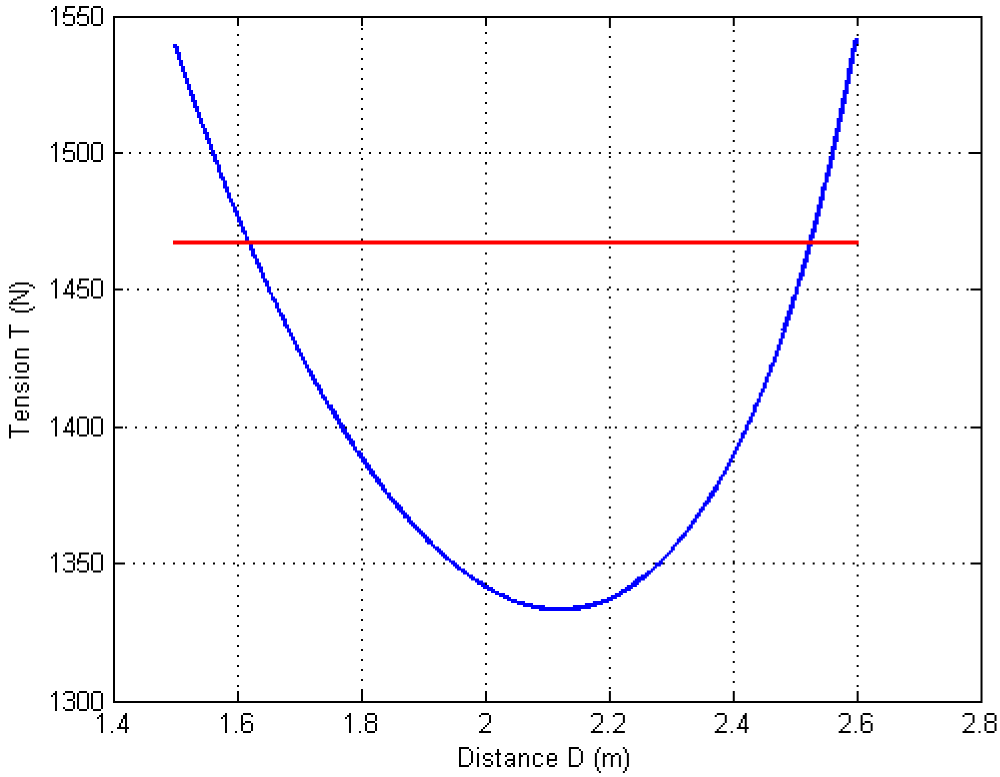
Figure P24

```
% Problem 2.24  Scott Thomas
clear
clc
disp('Problem 2.24: Scott Thomas')
W = 400; %Newtons
Lb = 3; %meters
Lc = 5; %meters
Dmin = 1.5;
DN = 1000;
Dmax = 2.6; %meters
D = linspace(Dmin,Dmax,DN);

% Part (a)
disp('Part (a): Find value of D than minimizes T, and Tmin')
T = Lb*Lc*W*(D.*sqrt(Lb^2 - D.^2)).^(-1);
[MinimumT,I] = min(T)
MinimumD = D(I)

% Part (b)
disp('Part (b): Plot T vs D. Find variation of D before T increases')
disp('10% above minimum value')
plot(D,T,'LineWidth',2), xlabel('Distance D (m)'), ylabel('Tension T (N)')
hold on
Tupten = MinimumT*1.1
```

```
D1 = [Dmin Dmax];
T1 = [Tupten Tupten];
plot(D1,T1,'r','LineWidth',2),grid
hold off
```

```
% Problem 2.24  Scott Thomas
clear
clc
disp('Problem 2.24: Scott Thomas')
W = 400; %Newtons
Lb = 3; %meters
Lc = 5; %meters
Dmin = 1.5;
DN = 1000;
Dmax = 2.6; %meters
D = linspace(Dmin,Dmax,DN);

% Part (a)
disp('Part (a): Find value of D than minimizes T, and Tmin')
T = Lb*Lc*W*(D.*sqrt(Lb^2 - D.^2)).^(-1);
[MinimumT,I] = min(T)
MinimumD = D(I)

% Part (b)
disp('Part (b): Plot T vs D. Find variation of D before T increases')
disp('10% above minimum value')
plot(D,T,'LineWidth',2), xlabel('Distance D (m)'), ylabel('Tension T (N)')
hold on
Tupten = MinimumT*1.1
D1 = [Dmin Dmax];
T1 = [Tupten Tupten];
plot(D1,T1,'r','LineWidth',2),grid
hold off
```

```
Problem 2.24: Scott Thomas
Part (a): Find value of D than minimizes T, and Tmin

MinimumT =

   1.3333e+03


I =

   565


MinimumD =

    2.1210

Part (b): Plot T vs D. Find variation of D before T increases
10% above minimum value

Tupten =

   1.4667e+03
```



Problem 2.31:

31.* The *scalar triple product* computes the magnitude M of the moment of a force vector $\mathbf{F}$ about a specified line. It is $M = (\mathbf{r} \times \mathbf{F}) \cdot \mathbf{n}$, where $\mathbf{r}$ is the position vector from the line to the point of application of the force and $\mathbf{n}$ is a unit vector in the direction of the line.

Use MATLAB to compute the magnitude M for the case where $\mathbf{F} = [12, -5, 4]$ N, $\mathbf{r} = [-3, 5, 2]$ m, and $\mathbf{n} = [6, 5, -7]$.

```
% Problem 2.31
clear
clc
disp('Problem 2.31: Scott Thomas')

F = [12 -5 4]
r = [-3 5 2]
n = [6 5 -7]

rcrossF = cross(r,F)
moment=rcrossF*n'
```

```
Problem 2.31: Scott Thomas

F =

    12    -5     4
```

```
r =

    -3     5     2


n =

     6     5    -7


rcrossF =

    30    36   -45


moment =

   675
```

Problem 2.33:

33. The area of a parallelogram can be computed from $|\mathbf{A} \times \mathbf{B}|$, where **A** and **B** define two sides of the parallelogram (see Figure P33). Compute the area of a parallelogram defined by $\mathbf{A} = 5\mathbf{i}$ and $\mathbf{B} = \mathbf{i} + 3\mathbf{j}$.

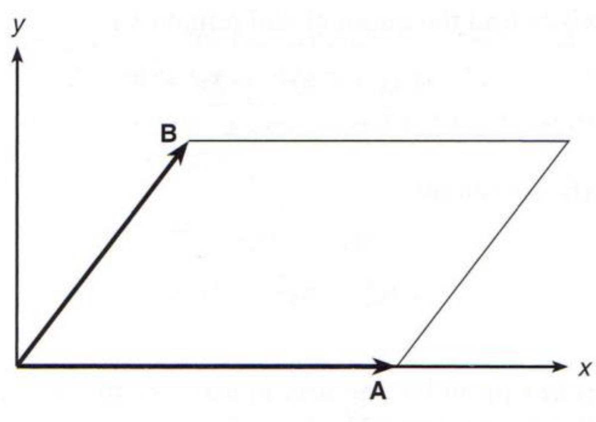


Figure P33

```
% Problem 2.33
clear
clc
disp('Problem 2.33: Scott Thomas')

A = [5 0 0]
B = [1 3 0]

C = cross(A,B)

Area=sqrt(sum(C.*C))
```

Problem 2.33: Scott Thomas

A =

5 0 0

B =

1 3 0

C =

0 0 15

Area =

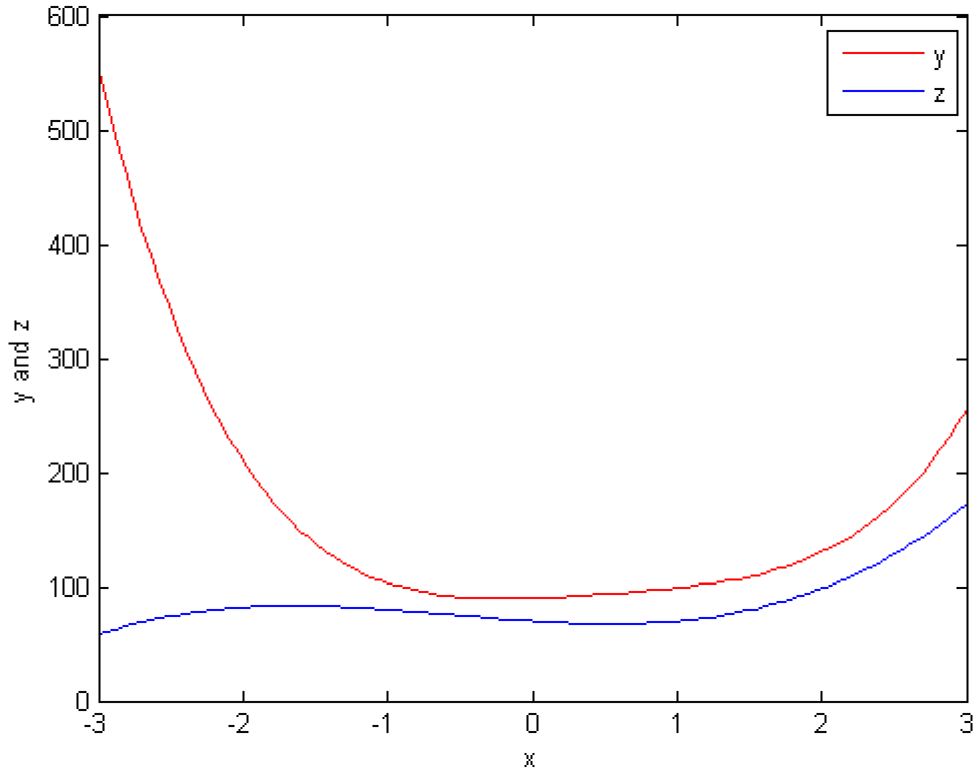
15

Problem 2.35:

35. Use MATLAB to plot the polynomials $y = 3x^4 - 6x^3 + 8x^2 + 4x + 90$ and $z = 3x^3 + 5x^2 - 8x + 70$ over the interval $-3 \leq x \leq 3$. Properly label the plot and each curve. The variables y and z represent current in milliamperes; the variable x represents voltage in volts.

```
% Problem 2.35
clear
clc
disp('Problem 2.35: Scott Thomas')

x = linspace(-3,3,100);
y = polyval([3 -6 8 4 90],x);
z = polyval([3 5 -8 70],x);

plot(x,y,'-r',x,z,'-b'),xlabel('x'),ylabel('y and z'),legend('y','z');
```

```
Problem 2.35: Scott Thomas
```


600
500
400
300
200
100
0
-3
-2
-1
0
1
2
3
x
y and z
y
z

Problem 2.43:

43. The following formulas are commonly used by engineers to predict the lift and drag of an airfoil:

$$L = \frac{1}{2}\rho C_L S V^2$$

$$D = \frac{1}{2}\rho C_D S V^2$$

where L and D are the lift and drag forces, V is the airspeed, S is the wing span, ρ is the air density, and C_L and C_D are the *lift* and *drag* coefficients. Both C_L and C_D depend on α, the angle of attack, the angle between the relative air velocity and the airfoil's chord line.

Wind tunnel experiments for a particular airfoil have resulted in the following formulas.

$$C_L = 4.47 \times 10^{-5}\alpha^3 + 1.15 \times 10^{-3}\alpha^2 + 6.66 \times 10^{-2}\alpha + 1.02 \times 10^{-1}$$

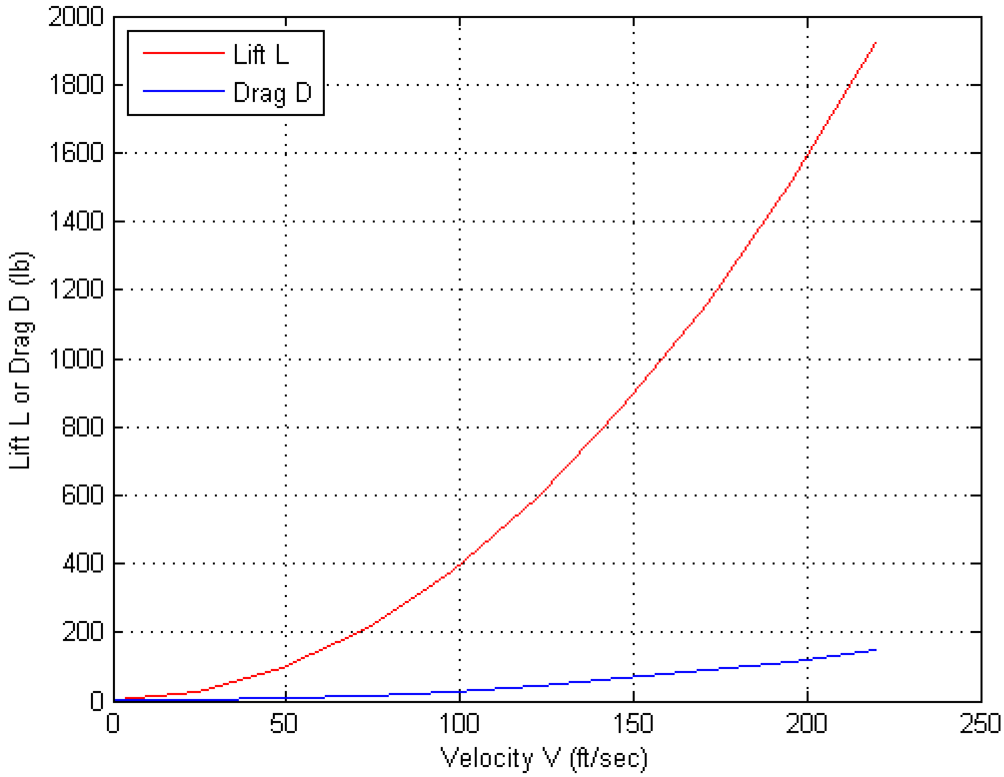
$$C_D = 5.75 \times 10^{-6}\alpha^3 + 5.09 \times 10^{-4}\alpha^2 + 1.8 \times 10^{-4}\alpha + 1.25 \times 10^{-2}$$

where α is in degrees.

Plot the lift and drag of this airfoil versus V for $0 \le V \le 150$ mi/hr (you must convert V to ft /sec; there is 5280 ft/mi). Use the values $\rho = 0.002378$ slug/ft^3 (air density at sea level), $\alpha = 10°$, and $S = 36$ ft. The resulting values of L and D will be in pounds.

```
% Problem 2.43
clear
clc
disp('Problem 2.43: Scott Thomas')

V = linspace(0,220,10); %ft/sec
rho = 0.002378; %slug/ft^3
alpha = 10; %degrees
S = 36; %ft

format short e
CL = [4.47E-5 1.15E-3 6.66E-2 1.02E-1];

CD = [5.75E-6 5.09E-4 1.8E-4 1.25E-2];

CL10 = polyval(CL,alpha);
CD10 = polyval(CD,alpha);

L = 0.5*rho*CL10*S.*V.^2;
D = 0.5*rho*CD10*S.*V.^2;

plot(V,L,'r',V,D,'b'),xlabel('Velocity V (ft/sec)'),...
    ylabel('Lift L or Drag D (lb)'),grid,legend('Lift L', 'Drag D'),...
    legend('Location','NorthWest');
```

```
Problem 2.43: Scott Thomas
```


Lift L
Drag D
Lift L or Drag D (lb)
Velocity V (ft/sec)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
50
100
150
200
250