**ME 1020 Engineering Programming with MATLAB**

**Handout 02**

**Homework 2 Assignment: 2.2, 2.5, 2.9, 2.12, 2.17, 2.24, 2.31, 2.33, 2.35, 2.43**

**Section 2.1**

**1.** *a.* Use two methods to create the vector **x** having 100 regularly spaced values starting at 5 and ending at 28.

*b.* Use two methods to create the vector **x** having a regular spacing of 0.2 starting at 2 and ending at 14.

*c.* Use two methods to create the vector **x** having 50 regularly spaced values starting at $-2$ and ending at 5.

**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.

**3.*** Use MATLAB to create a vector **x** having six values between 0 and 10 (including the endpoints 0 and 10). Create an array **A** whose first row contains the values $3x$ and whose second row contains the values $5x - 20$.

**4.** Repeat Problem 3 but make the first column of **A** contain the values $3x$ and the second column contain the values $5x - 20$.

**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**.

**6.** 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 $4 \times 3$ array **B** consisting of all elements in the second through fourth columns of **A**.

*b.* Create a $3 \times 4$ array **C** consisting of all elements in the second through fourth rows of **A**.

*c.* Create a $2 \times 3$ array **D** consisting of all elements in the first two rows and the last three columns of **A**.

**7.*** Compute the length and absolute value of the following vectors:

*a.* $\mathbf{x} = [2, 4, 7]$

*b.* $\mathbf{y} = [2, -4, 7]$

*c.* $\mathbf{z} = [5 + 3i, -3 + 4i, 2 - 7i]$

**8.** 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.* Find the maximum and minimum values in each column.
*b.* Find the maximum and minimum values in each row.

**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**.

**10.** Consider the following arrays.

$$\mathbf{A} = \begin{bmatrix} 1 & 4 & 2 \\ 2 & 4 & 100 \\ 7 & 9 & 7 \\ 3 & \pi & 42 \end{bmatrix} \qquad \mathbf{B} = \ln(\mathbf{A})$$

Write MATLAB expressions to do the following.
*a.* Select just the second row of **B**.
*b.* Evaluate the sum of the second row of **B**.
*c.* Multiply the second column of **B** and the first column of **A** element by element.
*d.* Evaluate the maximum value in the vector resulting from element-by-element multiplication of the second column of **B** with the first column of **A**.
*e.* Use element-by-element division to divide the first row of **A** by the first three elements of the third column of **B**. Evaluate the sum of the elements of the resulting vector.

## Section 2.2

**11.*** *a.* Create a three-dimensional array **D** whose three "layers" are these matrices:

$$\mathbf{A} = \begin{bmatrix} 3 & -2 & 1 \\ 6 & 8 & -5 \\ 7 & 9 & 10 \end{bmatrix} \quad \mathbf{B} = \begin{bmatrix} 6 & 9 & -4 \\ 7 & 5 & 3 \\ -8 & 2 & 1 \end{bmatrix} \quad \mathbf{C} = \begin{bmatrix} -7 & -5 & 2 \\ 10 & 6 & 1 \\ 3 & -9 & 8 \end{bmatrix}$$

*b.* Use MATLAB to find the largest element in each layer of **D** and the largest element in **D**.

## Section 2.3

**12.*** Given the matrices

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

Use MATLAB to

*a.* Find **A** + **B** + **C**.
*b.* Find **A** − **B** + **C**.
*c.* Verify the associative law

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

*d.* Verify the commutative law

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

**13.*** Given the matrices

$$\mathbf{A} = \begin{bmatrix} 56 & 32 \\ 24 & -16 \end{bmatrix} \quad \mathbf{B} = \begin{bmatrix} 14 & -4 \\ 6 & -2 \end{bmatrix}$$

Use MATLAB to

*a.* Find the result of **A** times **B** using the array product.
*b.* Find the result of **A** divided by **B** using array right division.
*c.* Find **B** raised to the third power element by element.

**14.*** The mechanical work $W$ done in using a force $F$ to push a block through a distance $D$ is $W = FD$. The following table gives data on the amount of force used to push a block through the given distance over five segments of a certain path. The force varies because of the differing friction properties of the surface.

| | Path segment | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Force (N) | 400 | 550 | 700 | 500 | 600 |
| Distance (m) | 3 | 0.5 | 0.75 | 1.5 | 5 |

Use MATLAB to find (*a*) the work done on each segment of the path and (*b*) the total work done over the entire path.

**15.** Plane A is heading southwest at 300 mi/hr, while plane B is heading west at 150 mi/hr. What are the velocity and the speed of plane A relative to plane B?

**16.** The following table shows the hourly wages, hours worked, and output (number of widgets produced) in one week for five widget makers.

| | Worker | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Hourly wage ($) | 5 | 5.50 | 6.50 | 6 | 6.25 |
| Hours worked | 40 | 43 | 37 | 50 | 45 |
| Output (widgets) | 1000 | 1100 | 1000 | 1200 | 1100 |

Use MATLAB to answer these questions:

*a.* How much did each worker earn in the week?
*b.* What is the total salary amount paid out?
*c.* How many widgets were made?
*d.* What is the average cost to produce one widget?
*e.* How many hours does it take to produce one widget on average?
*f.* Assuming that the output of each worker has the same quality, which worker is the most efficient? Which is the least efficient?

**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?

**18.** The potential energy stored in a spring is $kx^2/2$, where $k$ is the spring constant and $x$ is the compression in the spring. The force required to compress the spring is $kx$. The following table gives the data for five springs:

| | Spring | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Force (N) | 11 | 7 | 8 | 10 | 9 |
| Spring constant $k$ (N/m) | 1000 | 600 | 900 | 1300 | 700 |

Use MATLAB to find (*a*) the compression $x$ in each spring and (*b*) the potential energy stored in each spring.

**19.** A company must purchase five kinds of material. The following table gives the price the company pays per ton for each material, along with the number of tons purchased in the months of May, June, and July:

| | | Quantity purchased (tons) | | |
|---|---|---|---|---|
| **Material** | **Price ($/ton)** | **May** | **June** | **July** |
| 1 | 300 | 5 | 4 | 6 |
| 2 | 550 | 3 | 2 | 4 |
| 3 | 400 | 6 | 5 | 3 |
| 4 | 250 | 3 | 5 | 4 |
| 5 | 500 | 2 | 4 | 3 |

Use MATLAB to answer these questions:

*a.* Create a 5×3 matrix containing the amounts spent on each item for each month.

*b.* What is the total spent in May? in June? in July?

*c.* What is the total spent on each material in the three-month period?

*d.* What is the total spent on all materials in the three-month period?

**20.** A fenced enclosure consists of a rectangle of length $L$ and width $2R$, and a semicircle of radius $R$, as shown in Figure P20. The enclosure is to be built to have an area $A$ of 1600 ft$^2$. The cost of the fence is \$40/ft for the curved portion and \$30/ft for the straight sides. Use the `min` function to determine with a resolution of 0.01 ft the values of $R$ and $L$ required to minimize the total cost of the fence. Also compute the minimum cost.

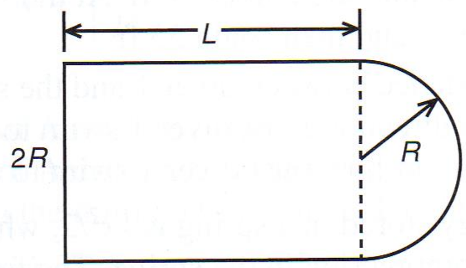


**Figure P20**

**21.** A water tank consists of a cylindrical part of radius $r$ and height $h$, and a hemispherical top. The tank is to be constructed to hold 500 m$^3$ of fluid when filled. The surface area of the cylindrical part is $2\pi rh$, and its volume is $\pi r^2 h$. The surface area of the hemispherical top is given by $2\pi r^2$, and its volume is given by $2\pi r^3/3$. The cost to construct the cylindrical part of the tank is \$300/m$^2$ of surface area; the hemispherical part costs \$400/m$^2$. Plot the cost versus $r$ for $2 \le r \le 10$ m, and determine the radius that results in the least cost. Compute the corresponding height $h$.

**22.** Write a MATLAB assignment statement for each of the following functions, assuming that $w$, $x$, $y$, and $z$ are row vectors of equal length and that $c$ and $d$ are scalars.

$$f = \frac{1}{\sqrt{2\pi c/x}} \qquad E = \frac{x + w/(y + z)}{x + w/(y - z)}$$

$$A = \frac{e^{-c/(2x)}}{(\ln y)\sqrt{dz}} \qquad S = \frac{x(2.15 + 0.35y)^{1.8}}{z(1 - x)^y}$$

**23.** *a.* After a dose, the concentration of medication in the blood declines due to metabolic processes. The *half-life* of a medication is the time required after an initial dosage for the concentration to be reduced by one-half. A common model for this process is

$$C(t) = C(0)e^{-kt}$$

where $C(0)$ is the initial concentration, $t$ is time (in hours), and $k$ is called the *elimination rate constant,* which varies among individuals. For a particular bronchodilator, $k$ has been estimated to be in the range $0.047 \leq k \leq 0.107$ per hour. Find an expression for the half-life in terms of $k$, and obtain a plot of the half-life versus $k$ for the indicated range.

*b.* If the concentration is initially zero and a constant delivery rate is started and maintained, the concentration as a function of time is described by

$$C(t) = \frac{a}{k}(1 - e^{-kt})$$

where $a$ is a constant that depends on the delivery rate. Plot the concentration after 1 hr, $C(1)$, versus $k$ for the case where $a = 1$ and $k$ is in the range $0.047 \leq k \leq 0.107$ per hour.

**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.

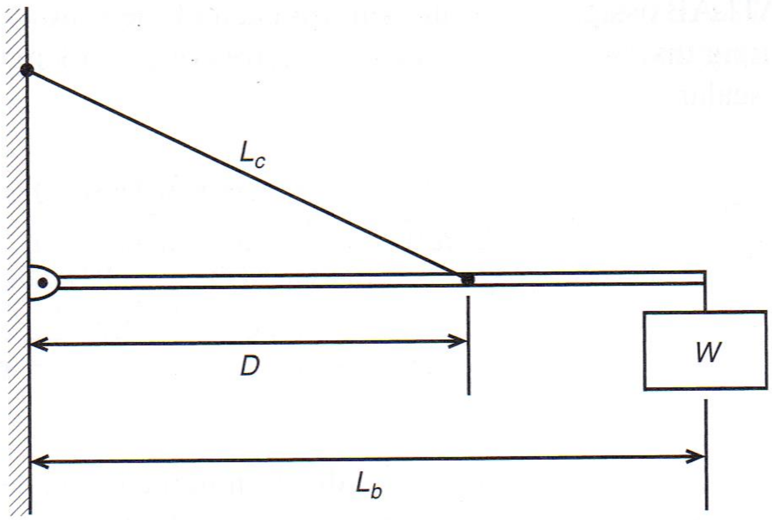


**Figure P24**

*a.* For the case where $W = 400$ N, $L_b = 3$ m, and $L_c = 5$ m, use element-by-element operations and the `min` function to compute the value of $D$ that minimizes the tension $T$. Compute the minimum tension value.

*b.* Check the sensitivity of the solution by plotting $T$ versus $D$. How much can $D$ vary from its optimal value before the tension $T$ increases 10 percent above its minimum value?

## Section 2.4

**25.*** Use MATLAB to find the products **AB** and **BA** for the following matrices:

$$\mathbf{A} = \begin{bmatrix} 11 & 5 \\ -9 & -4 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -7 & -8 \\ 6 & 2 \end{bmatrix}$$

**26.** Given the matrices

$$\mathbf{A} = \begin{bmatrix} 4 & -2 & 1 \\ 6 & 8 & -5 \\ 7 & 9 & 10 \end{bmatrix} \quad \mathbf{B} = \begin{bmatrix} 6 & 9 & -4 \\ 7 & 5 & 3 \\ -8 & 2 & 1 \end{bmatrix} \quad \mathbf{C} = \begin{bmatrix} -4 & -5 & 2 \\ 10 & 6 & 1 \\ 3 & -9 & 8 \end{bmatrix}$$

Use MATLAB to

*a.* Verify the associative property

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

*b.* Verify the distributive property

$$\mathbf{(AB)C = A(BC)}$$

**27.** The following tables show the costs associated with a certain product and the production volume for the four quarters of the business year. Use MATLAB to find (*a*) the quarterly costs for materials, labor, and transportation;

(*b*) the total material, labor, and transportation costs for the year; and (*c*) the total quarterly costs.

| Product | Unit product costs ($\$ \times 10^3$) Materials | Labor | Transportation |
|---|---|---|---|
| 1 | 7 | 3 | 2 |
| 2 | 3 | 1 | 3 |
| 3 | 9 | 4 | 5 |
| 4 | 2 | 5 | 4 |
| 5 | 6 | 2 | 1 |

| Product | Quarterly production volume Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 |
|---|---|---|---|---|
| 1 | 16 | 14 | 10 | 12 |
| 2 | 12 | 15 | 11 | 13 |
| 3 | 8 | 9 | 7 | 11 |
| 4 | 14 | 13 | 15 | 17 |
| 5 | 13 | 16 | 12 | 18 |

**28.*** Aluminum alloys are made by adding other elements to aluminum to improve its properties, such as hardness or tensile strength. The following table shows the composition of five commonly used alloys, which are known by their alloy numbers (2024, 6061, and so on) [Kutz, 1999]. Obtain a matrix algorithm to compute the amounts of raw materials needed to produce a given amount of each alloy. Use MATLAB to determine how much raw material of each type is needed to produce 1000 tons of each alloy.

| Alloy | Composition of aluminum alloys %Cu | %Mg | %Mn | %Si | %Zn |
|---|---|---|---|---|---|
| 2024 | 4.4 | 1.5 | 0.6 | 0 | 0 |
| 6061 | 0 | 1 | 0 | 0.6 | 0 |
| 7005 | 0 | 1.4 | 0 | 0 | 4.5 |
| 7075 | 1.6 | 2.5 | 0 | 0 | 5.6 |
| 356.0 | 0 | 0.3 | 0 | 7 | 0 |

**29.** Redo Example 2.4–4 as a script file to allow the user to examine the effects of labor costs. Allow the user to input the four labor costs in the following table. When you run the file, it should display the quarterly costs and the category costs. Run the file for the case where the unit labor costs are \$3000, \$7000, \$4000, and \$8000, respectively.

Product costs

| Unit costs ($\$ \times 10^3$) | | | |
|---|---|---|---|
| **Product** | **Materials** | **Labor** | **Transportation** |
| 1 | 6 | 2 | 1 |
| 2 | 2 | 5 | 4 |
| 3 | 4 | 3 | 2 |
| 4 | 9 | 7 | 3 |

Quarterly production volume

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

**30.** Vectors with three elements can represent position, velocity, and acceleration. A mass of 5 kg, which is 3 m away from the $x$ axis, starts at $x = 2$ m and moves with a speed of 10 m/s parallel to the $y$ axis. Its velocity is thus described by $\mathbf{v} = [0, 10, 0]$, and its position is described by $\mathbf{r} = [2, 10t + 3, 0]$. Its angular momentum vector $\mathbf{L}$ is found from $\mathbf{L} = m(\mathbf{r} \times \mathbf{v})$, where $m$ is the mass. Use MATLAB to

*a.* Compute a matrix **P** whose 11 rows are the values of the position vector **r** evaluated at the times $t = 0, 0.5, 1, 1.5, \ldots, 5$ s.
*b.* What is the location of the mass when $t = 5$ s?
*c.* Compute the angular momentum vector **L.** What is its direction?

**31.*** The *scalar triple product* computes the magnitude $M$ of the moment of a force vector **F** about a specified line. It is $M = (\mathbf{r} \times \mathbf{F}) \cdot \mathbf{n}$, where **r** is the position vector from the line to the point of application of the force and **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 $\mathbf{n} = [6, 5, -7]$.

**32.** Verify the identity

$$\mathbf{A} \times (\mathbf{B} \times \mathbf{C}) = \mathbf{B}(\mathbf{A} \cdot \mathbf{C}) - \mathbf{C}(\mathbf{A} \cdot \mathbf{B})$$

for the vectors $\mathbf{A} = 7\mathbf{i} - 3\mathbf{j} + 7\mathbf{k}$, $\mathbf{B} = -6\mathbf{i} + 2\mathbf{j} + 3\mathbf{k}$, and $\mathbf{C} = 2\mathbf{i} + 8\mathbf{j} - 8\mathbf{k}$.

**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 $\mathbf{B} = \mathbf{i} + 3\mathbf{j}$.

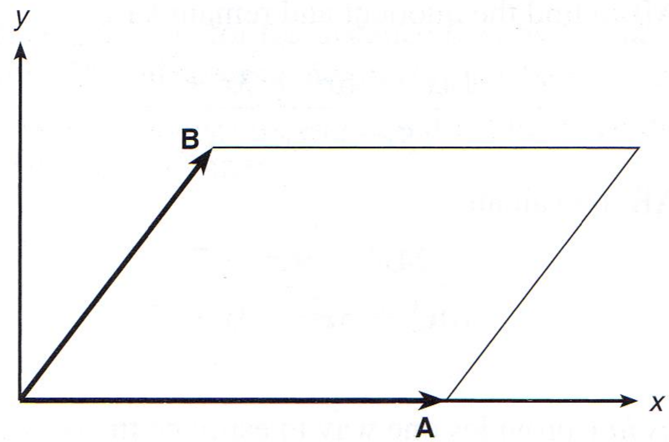


**Figure P33**

**34.** The volume of a parallelepiped can be computed from $|\mathbf{A} \cdot (\mathbf{B} \times \mathbf{C})|$, where **A**, **B**, and **C** define three sides of the parallelepiped (see Figure P34). Compute the volume of a parallelepiped defined by $\mathbf{A} = 5\mathbf{i}$, $\mathbf{B} = 2\mathbf{i} + 4\mathbf{j}$, and $\mathbf{C} = 3\mathbf{i} - 2\mathbf{k}$.

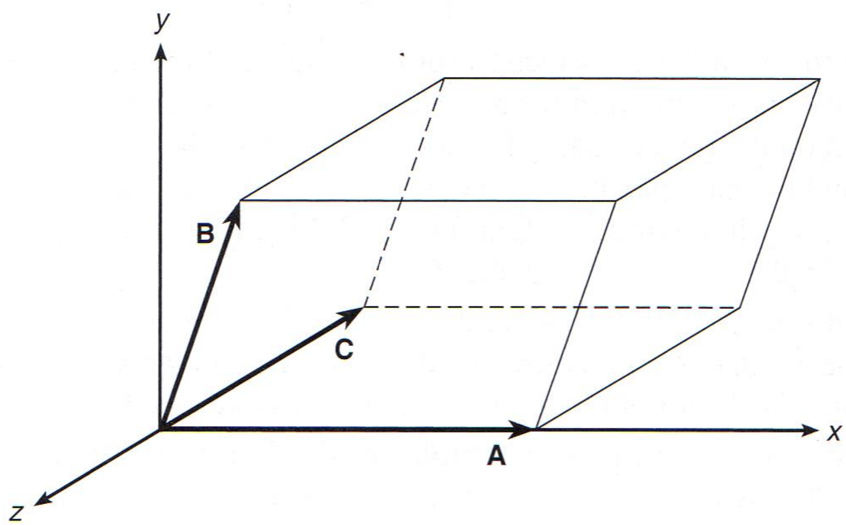


**Figure P34**

## Section 2.5

**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.

**36.** Use MATLAB to plot the polynomial $y = 3x^4 - 5x^3 - 28x^2 - 5x + 200$ on the interval $-1 \leq x \leq 1$. Put a grid on the plot and use the `ginput` function to determine the coordinates of the peak of the curve.

**37.** Use MATLAB to find the following product:

$$(10x^3 - 9x^2 - 6x + 12)(5x^3 - 4x^2 - 12x + 8)$$

**38.*** Use MATLAB to find the quotient and remainder of

$$\frac{14x^3 - 6x^2 + 3x + 9}{5x^2 + 7x - 4}$$

**39.*** Use MATLAB to evaluate

$$\frac{24x^3 - 9x^2 - 7}{10x^3 + 5x^2 - 3x - 7}$$

at $x = 5$.

**40.** The *ideal gas law* provides one way to estimate the pressures and volumes of a gas in a container. The law is

$$P = \frac{RT}{\hat{V}}$$

More accurate estimates can be made with the *van der Waals* equation

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

where the term $b$ is a correction for the volume of the molecules and the term $a/\hat{V}^2$ is a correction for molecular attractions. The values of $a$ and $b$ depend on the type of gas. The gas constant is $R$, the *absolute* temperature is $T$, and the gas specific volume is $\hat{V}$. If 1 mol of an ideal gas were confined to a volume of 22.41 L at 0°C (273.2 K), it would exert a pressure of 1 atm. In these units, $R = 0.08206$.

For chlorine ($Cl_2$), $a = 6.49$ and $b = 0.0562$. Compare the specific volume estimates $\hat{V}$ given by the ideal gas law and the van der Waals equation for 1 mol of $Cl_2$ at 300 K and a pressure of 0.95 atm.

**41.** Aircraft A is flying east at 320 mi/hr, while aircraft B is flying south at 160 mi/hr. At 1:00 P.M. the aircraft are located as shown in Figure P41.

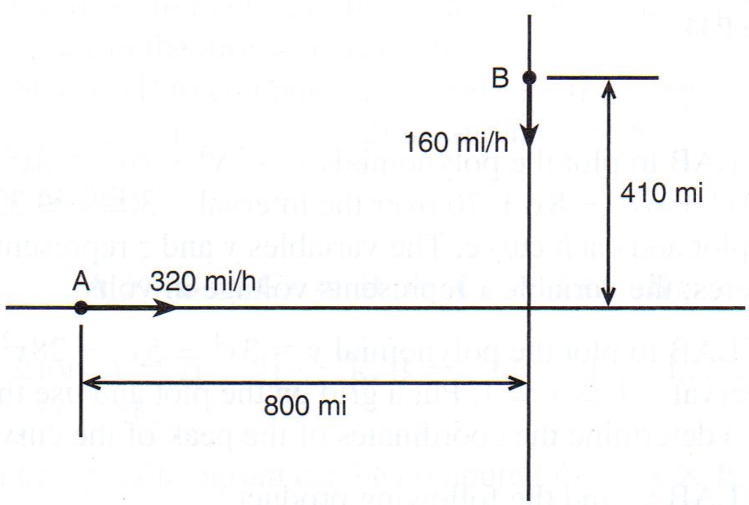


**Figure P41**

*a.* Obtain the expression for the distance $D$ between the aircraft as a function of time. Plot $D$ versus time until $D$ reaches its minimum value.

*b.* Use the `roots` function to compute the time when the aircraft are first within 30 mi of each other.

**42.** The function

$$y = \frac{3x^2 - 12x + 20}{x^2 - 7x + 10}$$

approaches $\infty$ as $x \to 2$ and as $x \to 5$. Plot this function over the range $0 \leq x \leq 7$. Choose an appropriate range for the $y$ axis.

**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, $\rho$ is the air density, and $C_L$ and $C_D$ are the *lift* and *drag* coefficients. Both $C_L$ and $C_D$ depend on $\alpha$, 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 $\alpha$ is in degrees.

Plot the lift and drag of this airfoil versus $V$ for $0 \leq V \leq 150$ 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.

**44.** The lift-to-drag ratio is an indication of the effectiveness of an airfoil. Referring to Problem 43, the equations for lift and drag are

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

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

where, for a particular airfoil, the lift and drag coefficients versus angle of attack $\alpha$ are given by

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

$$C_D = 5.75 \times 10^{-6}\alpha^3 + 5.09 \times 10^{-4}\alpha^2 + 1.81 \times 10^{-4}\alpha + 1.25 \times 10^{-2}$$

Using the first two equations, we see that the lift-to-drag ratio is given simply by the ratio $C_L/C_D$.

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

Plot $L/D$ versus $\alpha$ for $-2° \le \alpha \le 22°$. Determine the angle of attack that maximizes $L/D$.

## Section 2.6

**45.** *a.* Use both cell indexing and content indexing to create the following $2 \times 2$ cell array.

| Motor 28C | Test ID 6 |
|---|---|
| $\begin{bmatrix} 3 & 9 \\ 7 & 2 \end{bmatrix}$ | [6 5 1] |

*b.* What are the contents of the (1,1) element in the (2,1) cell in this array?

**46.** The capacitance of two parallel conductors of length $L$ and radius $r$, separated by a distance $d$ in air, is given by

$$C = \frac{\pi \epsilon L}{\ln[(d - r)/r]}$$

where $\epsilon$ is the permittitivity of air ($\epsilon = 8.854 \times 10^{-12}$ F/m). Create a cell array of capacitance values versus $d$, $L$, and $r$ for $d = 0.003, 0.004, 0.005$, and 0.01 m; $L = 1, 2, 3$ m; and $r = 0.001, 0.002, 0.003$ m. Use MATLAB to determine the capacitance value for $d = 0.005$, $L = 2$, and $r = 0.001$.

## Section 2.7

**47.** *a.* Create a structure array that contains the conversion factors for converting units of mass, force, and distance between the metric SI system and the British Engineering System.

*b*. Use your array to compute the following:

- The number of meters in 48 ft.
- The number of feet in 130 m.
- The number of pounds equivalent to 36 N.
- The number of newtons equivalent to 10 lb.
- The number of kilograms in 12 slugs.
- The number of slugs in 30 kg.

**48.** Create a structure array that contains the following information fields concerning the road bridges in a town: bridge location, maximum load (tons), year built, year due for maintenance. Then enter the following data into the array:

| Location | Max. load | Year built | Due for maintenance |
|---|---|---|---|
| Smith St. | 80 | 1928 | 2011 |
| Hope Ave. | 90 | 1950 | 2013 |
| Clark St. | 85 | 1933 | 2012 |
| North Rd. | 100 | 1960 | 2012 |

**49.** Edit the structure array created in Problem 48 to change the maintenance data for the Clark St. bridge from 2012 to 2018.

**50.** Add the following bridge to the structure array created in Problem 48.

| Location | Max. load | Year built | Due for maintenance |
|---|---|---|---|
| Shore Rd. | 85 | 1997 | 2014 |