**ME 1020 Engineering Programming with MATLAB**

**Handout 01**

**Homework 1 Assignment: Problems 1.2, 1.5, 1.8, 1.11, 1.18, 1.23, 1.25, 1.30**

## Section 1.1

**1.** Make sure you know how to start and quit a MATLAB session. Use MATLAB to make the following calculations, using the values $x = 10$, $y = 3$. Check the results by using a calculator.

*a.* $u = x + y$ *b.* $v = xy$ *c.* $w = x / y$

*d.* $z = \sin x$ *e.* $r = 8 \sin y$ *f.* $s = 5 \sin (2y)$

**2.*** Suppose that $x = 2$ and $y = 5$. Use MATLAB to compute the following.

*a.* $\dfrac{yx^3}{x - y}$ *b.* $\dfrac{3x}{2y}$ *c.* $\dfrac{3}{2}xy$ *d.* $\dfrac{x^5}{x^5 - 1}$

**3.** Suppose that $x = 3$ and $y = 4$. Use MATLAB to compute the following, and check the results with a calculator.

*a.* $\left(1 - \dfrac{1}{x^5}\right)^{-1}$ *b.* $3\pi x^2$ *c.* $\dfrac{3y}{4x - 8}$ *d.* $\dfrac{4(y - 5)}{3x - 6}$

**4.** Evaluate the following expressions in MATLAB for the given value of $x$. Check your answers by hand.

*a.* $y = 6x^3 + \dfrac{4}{x}, \quad x = 3$ *b.* $y = \dfrac{x}{4}3, \quad x = 7$

*c.* $y = \dfrac{(4x)^2}{25}, \quad x = 9$ *d.* $y = 2\dfrac{\sin x}{5}, \quad x = 4$

*e.* $y = 7(x^{1/3}) + 4x^{0.58}, \quad x = 30$

**5.** Assuming that the variables $a$, $b$, $c$, $d$, and $f$ are scalars, write MATLAB statements to compute and display the following expressions. Test your statements for the values $a = 1.12$, $b = 2.34$, $c = 0.72$, $d = 0.81$, and $f = 19.83$.

$$x = 1 + \frac{a}{b} + \frac{c}{f^2} \qquad s = \frac{b - a}{d - c}$$

$$r = \frac{1}{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}} \qquad y = ab\frac{1}{c}\frac{f^2}{2}$$

**6.** Use MATLAB to calculate

*a.* $\frac{3}{4}(6)(7^2) + \frac{4^5}{7^3 - 145}$ *b.* $\frac{48.2(55) - 9^3}{53 + 14^2}$

*c.* $\frac{27^2}{4} + \frac{319^{4/5}}{5} + 60(14)^{-3}$

Check your answers with a calculator.

**7.** The volume of a sphere is given by $V = 4\pi r^3/3$, where $r$ is the radius. Use MATLAB to compute the radius of a sphere having a volume 40 percent greater than that of a sphere of radius 4 ft.

**8.*** Suppose that $x = -7 - 5i$ and $y = 4 + 3i$. Use MATLAB to compute

*a.* $x + y$ *b.* $xy$ *c.* $x/y$

**9.** Use MATLAB to compute the following. Check your answers by hand.

*a.* $(3 + 6i)(-7 - 9i)$ *b.* $\frac{5 + 4i}{5 - 4i}$

*c.* $\frac{3}{2}i$ *d.* $\frac{3}{2i}$

**10.** Evaluate the following expressions in MATLAB, for the values $x = 5 + 8i$, $y = -6 + 7i$. Check your answers by hand.

*a.* $u = x + y$ *b.* $v = xy$ *c.* $w = x/y$

*d.* $z = e^x$ *e.* $r = \sqrt{y}$ *f.* $s = xy^2$

**11.** The *ideal gas law* provides one way to estimate the pressure exerted by a gas in a container. The law is

$$P = \frac{nRT}{V}$$

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

$$P = \frac{nRT}{V - nb} - \frac{an^2}{V^2}$$

where the term $nb$ is a correction for the volume of the molecules and the term $an^2/V^2$ 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 $T$, the gas volume is $V$, and the number of gas molecules is indicated by $n$. If $n = 1$ mol of an ideal gas were confined to a volume of $V = 22.41$ 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 pressure estimates given by the ideal gas law and the van der Waals equation for 1 mol of $Cl_2$ in 22.41 L at 273.2 K. What is the main cause of the difference in the two pressure estimates, the molecular volume or the molecular attractions?

**12.** The *ideal gas law* relates the pressure $P$, volume $V$, absolute temperature $T$, and amount of gas $n$. The law is

$$P = \frac{nRT}{V}$$

where $R$ is the gas constant.

An engineer must design a large natural gas storage tank to be expandable to maintain the pressure constant at 2.2 atm. In December when the temperature is 4°F (−15°C), the volume of gas in the tank is 28 500 ft$^3$. What will the volume of the same quantity of gas be in July when the temperature is 88°F (31°C)? (*Hint*: Use the fact that $n$, $R$, and $P$ are constant in this problem. Note also that K = °C + 273.2.)

## Section 1.3

**13.** Suppose $x$ takes on the values $x = 1, 1.2, 1.4, \ldots, 5$. Use MATLAB to compute the array `y` that results from the function $y = 7\sin(4x)$. Use MATLAB to determine how many elements are in the array `y` and the value of the third element in the array `y`.

**14.** Use MATLAB to determine how many elements are in the array `sin(-pi/2):0.05:cos(0)`. Use MATLAB to determine the 10th element.

**15.** Use MATLAB to calculate

*a.* $e^{(-2.1)^3} + 3.47\log(14) + \sqrt[4]{287}$ *b.* $(3.4)^7\log(14) + \sqrt[4]{287}$

*c.* $\cos^2\left(\frac{4.12\pi}{6}\right)$ *d.* $\cos\left(\frac{4.12\pi}{6}\right)^2$

Check your answers with a calculator.

**16.** Use MATLAB to calculate

*a.* $6\pi\tan^{-1}(12.5) + 4$ *b.* $5\tan[3\sin^{-1}(13/5)]$

*c.* $5\ln(7)$ *d.* $5\log(7)$

Check your answers with a calculator.

**17.** The Richter scale is a measure of the intensity of an earthquake. The energy $E$ (in joules) released by the quake is related to the magnitude $M$ on the Richter scale as follows.

$$E = 10^{4.4}10^{1.5M}$$

How much more energy is released by a magnitude 7.6 quake than a 5.6 quake?

**18.*** Use MATLAB to find the roots of $13x^3 + 182x^2 - 184x + 2503 = 0$.

**19.** Use MATLAB to find the roots of the polynomial $70x^3 + 24x^2 - 10x + 20$.

**20.** Determine which search path MATLAB uses on your computer. If you use a lab computer as well as a home computer, compare the two search paths. Where will MATLAB look for a user-created M-file on each computer?

**21.** Use MATLAB to plot the function $T = 6 \ln t - 7e^{0.2t}$ over the interval $1 \leq t \leq 3$. Put a title on the plot and properly label the axes. The variable $T$ represents temperature in degrees Celsius; the variable $t$ represents time in minutes.

**22.** Use MATLAB to plot the functions $u = 2 \log_{10}(60x + 1)$ and $v = 3 \cos(6x)$ over the interval $0 \leq x \leq 2$. Properly label the plot and each curve. The variables $u$ and $v$ represent speed in miles per hour; the variable $x$ represents distance in miles.

**23.** The Fourier series is a series representation of a periodic function in terms of sines and cosines. The Fourier series representation of the function

$$f(x) = \begin{cases} 1 & 0 < x < \pi \\ -1 & -\pi < x < 0 \end{cases}$$

is

$$\frac{4}{\pi}\left(\frac{\sin x}{1} + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} + \frac{\sin 7x}{7} + \cdots\right)$$

Plot on the same graph the function $f(x)$ and its series representation, using the four terms shown.

**24.** A *cycloid* is the curve described by a point $P$ on the circumference of a circular wheel of radius $r$ rolling along the $x$ axis. The curve is described in parametric form by the equations

$$x = r(\phi - \sin \phi)$$
$$y = r(1 - \cos \phi)$$

Use these equations to plot the cycloid for $r = 10$ in. and $0 \leq \phi \leq 4\pi$.

## Section 1.4

**25.** A fence around a field is shaped as shown in Figure P25. It consists of a rectangle of length $L$ and width $W$ and a right triangle that is symmetric about the central horizontal axis of the rectangle. Suppose the width $W$ is known (in meters) and the enclosed area $A$ is known (in square meters). Write a MATLAB script file in terms of the given variables $W$ and $A$ to determine the length $L$ required so that the enclosed area is $A$. Also determine the total length of fence required. Test your script for the values $W = 6$ m and $A = 80$ m$^2$.

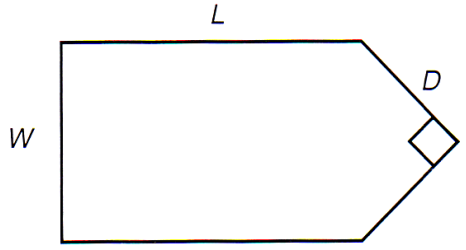


**Figure P25**

**26.** The four-sided figure shown in Figure P26 consists of two triangles having a common side $a$. The law of cosines for the top triangle states that

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

and a similar equation can be written for the bottom triangle. Develop a procedure for computing the length of side $c_2$ if you are given the lengths of sides $b_1$, $b_2$, and $c_1$ and the angles $A_1$ and $A_2$ in degrees. Write a script file to implement this procedure. Test your script, using the following values: $b_1 = 180$ m, $b_2 = 165$ m, $c_1 = 115$ m, $A_1 = 120°$, and $A_2 = 100°$.

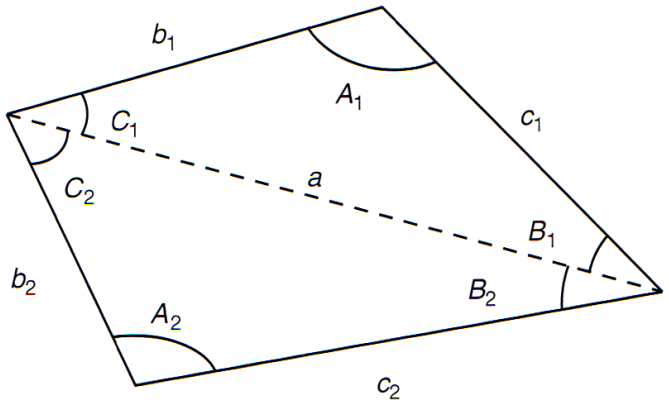


**Figure P26**

## Section 1.5

**27.** Use the MATLAB Help facilities to find information about the following topics and symbols: plot, label, cos, cosine, :, and *.

**28.** Use the MATLAB Help facilities to determine what happens if you use the `sqrt` function with a negative argument.

**29.** Use the MATLAB Help facilities to determine what happens if you use the `exp` function with an imaginary argument.

## Section 1.6

**30.** *a.* With what initial speed must you throw a ball vertically for it to reach a height of 20 ft? The ball weighs 1 lb. How does your answer change if the ball weighs 2 lb?