**ME 1020 Engineering Programming with MATLAB**

**Handout 03**

**Homework 3 Assignment: 3.4, 3.6, 3.10, 3.12, 3.16, 3.18, 3.24**

4. Create a vector for $x$ over the range $-2\pi \leq x \leq 2\pi$. Use a MATLAB script file to plot both sinh($x$) and $(e^x - e^{-x})/2$ to show that they are the same function.

5. Create a vector for $x$ over the range $1 \leq x \leq 10\pi$. Use a MATLAB script file to plot both $\cosh^{-1}(x)$ and $\ln\left(x + \sqrt{x^2 - 1}\right)$ to show that they are the same function.

6. 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 permittivity of air ($\epsilon = 8.854 \times 10^{-12}$ F/m). Create a vector for $d$ over the range $0.002 \leq d \leq 0.010$ m. Use a MATLAB script file to plot the capacitance over the range of $d$ for $L$ = 1 m and $r$ = 0.001 m.

7. When a belt is wrapped around a cylinder, the relation between the belt forces on each side of the cylinder is

$$F_1 = F_2 e^{\mu \beta}$$

where $\beta$ is the angle of wrap of the belt in radians and $\mu$ is the friction coefficient. Create a vector for $\beta$ over the range $10 \leq \beta \leq 720°$. Use a MATLAB script file to plot the force $F_1$ over the range of $\beta$ for $\mu$ = 0.3 and $F_2$ = 100 N. (Hint: Be careful with $\beta$!)

9. Create a function file that accepts temperature in degrees Fahrenheit (°F) and computes the corresponding value in degrees Celsius (°C). The relation between the two is

$$T°\text{C} = \frac{5}{9}(T°\text{F} - 32)$$

Create a Calling Script File to plot the temperature in °C versus the temperature in °F over the range $0 \leq T \leq 250$°F.

10. An object thrown vertically with a speed $v_0$ reaches a height $h$ at time $t$, where

$$h = v_0 t - \frac{1}{2} g t^2$$

Create a function file that computes the height $h$ as a function of time $t$ for $g$ = 9.81 m/s$^2$ and $v_0$ = 50 m/s. Create a Calling Script File to plot the height versus the time $t$. Determine the time when the object hits the ground using the **fzero** command.

11. function file that accepts temperature in degrees Fahrenheit (°F) and computes

**11.** 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 600 $m^3$ 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 $400 per square meter of surface area; the hemispherical part costs $600 per square meter. Use the `fminbnd` function to compute the radius that results in the least cost. Compute the corresponding height $h$.

**12.** A fence around a field is shaped as shown in Figure P12. It consists of a rectangle of length $L$ and width $W$, and a right triangle that is symmetrical 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 user-defined function file with $W$ and $A$ as inputs. The outputs are the length $L$ required so that the enclosed area is $A$ and the total length of fence required. Test your function for the values $W = 6$ m and $A = 80$ $m^2$.

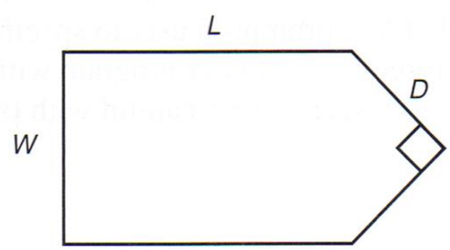


**Figure P12**

**13.** A fenced enclosure consists of a rectangle of length $L$ and width $2R$ and a semicircle of radius $R$, as shown in Figure P13. The enclosure is to be built to have an area $A$ of 2000 $ft^2$. The cost of the fence is $50 per foot for the curved portion and $40 per foot for the straight sides. Use the `fminbnd` 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.

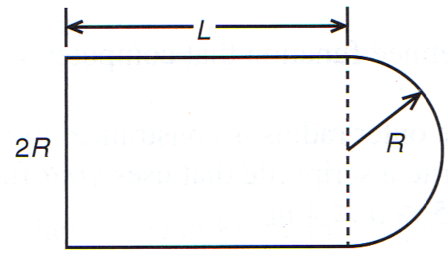


**Figure P13**

**14.** Using estimates of rainfall, evaporation, and water consumption, the town engineer developed the following model of the water volume in the reservoir as a function of time

$$V(t) = 10^9 + 10^8(1 - e^{-t/100}) - rt$$

where $V$ is the water volume in liters, $t$ is time in days, and $r$ is the town's consumption rate in liters per day. Write two user-defined functions. The first function should define the function $V(t)$ for use with the `fzero` function. The second function should use `fzero` to compute how long it will take for the water volume to decrease to $x$ percent of its initial value of $10^9$ L. The inputs to the second function should be $x$ and $r$. Test your functions for the case where $x = 50$ percent and $r = 10^7$ L/day.

**15.** The volume $V$ and paper surface area $A$ of a conical paper cup are given by

$$V = \frac{1}{3}\pi r^2 h \qquad A = \pi r\sqrt{r^2 + h^2}$$

where $r$ is the radius of the base of the cone and $h$ is the height of the cone.

*a.* By eliminating $h$, obtain the expression for $A$ as a function of $r$ and $V$.
*b.* Create a user-defined function that accepts $R$ as the only argument and computes $A$ for a given value of $V$. Declare $V$ to be global within the function.
*c.* For $V = 10$ in.$^3$, use the function with the `fminbnd` function to compute the value of $r$ that minimizes the area $A$. What is the corresponding value of the height $h$? Investigate the sensitivity of the solution by plotting $V$ versus $r$. How much can $R$ vary about its optimal value before the area increases 10 percent above its minimum value?

**16.** A torus is shaped like a doughnut. If its inner radius is $a$ and its outer radius is $b$, its volume and surface area are given by

$$V = \frac{1}{4}\pi^2(a + b)(b - a)^2 \qquad A = \pi^2(b^2 - a^2)$$

*a.* Create a user-defined function that computes $V$ and $A$ from the arguments $a$ and $b$.

*b.* Suppose that the outer radius is constrained to be 2 in. greater than the inner radius. Write a script file that uses your function to plot $A$ and $V$ versus $a$ for $0.25 \le a \le 4$ in.

**17.** Suppose it is known that the graph of the function $y = ax^3 + bx^2 + cx + d$ passes through four given points $(x_i, y_i)$, $i = 1, 2, 3, 4$. Write a user-defined function that accepts these four points as input and computes the coefficients $a$, $b$, $c$, and $d$. The function should solve four linear equations in terms of the four unknowns $a$, $b$, $c$, and $d$. Test your function for the case where $(x_i, y_i) = (-2, -20)$, $(0, 4)$, $(2, 68)$, and $(4, 508)$, whose answer is $a = 7$, $b = 5$, $c = -6$, and $d = 4$.

## Section 3.3

**18.** Create an anonymous function for $10e^{-2x}$ and use it to plot the function over the range $0 \le x \le 2$.

**19.** Create an anonymous function for $20x^2 - 200x + 3$ and use it

*a.* To plot the function to determine the approximate location of its minimum

*b.* With the `fminbnd` function to precisely determine the location of the minimum

**20.** Create four anonymous functions to represent the function $6e^{3\cos x^2}$, which is composed of the functions $h(z) = 6e^z$, $g(y) = 3\cos y$, and $f(x) = x^2$. Use the anonymous functions to plot $6e^{3\cos x^2}$ over the range $0 \le x \le 4$.

**21.** Use a primary function with a subfunction to compute the zeros of the function $3x^3 - 12x^2 - 33x + 80$ over the range $-10 \le x \le 10$.

**22.** Create a primary function that uses a function handle with a nested function to compute the minimum of the function $20x^2 - 200x + 12$ over the range $0 \le x \le 10$.

## Section 3.4

**23.** Use a text editor to create a file containing the following data. Then use the `load` function to load the file into MATLAB, and use the `mean` function to compute the mean value of each column.

| | | |
|---|---|---|
| 55 | 42 | 98 |
| 49 | 39 | 95 |
| 63 | 51 | 92 |
| 58 | 45 | 90 |

**24.** Enter and save the data given in Problem 23 in a spreadsheet. Then import the spreadsheet file into the MATLAB variable `A`. Use MATLAB to compute the sum of each column.

**25.** Use a text editor to create a file from the data given in Problem 23, but separate each number with a semicolon. Then use the Import Wizard to load and save the data in the MATLAB variable `A`.