MULTIPLE CHOICE TEST
Chapter 5
How Do I use Matrices?

1. The MATLAB command that outputs the number of rows and columns of a matrix is
   a) `dimensions`
   b) `mdim`
   c) `msize`
   d) `size`

2. When inputting a matrix, each new row is separated by a
   a) `:`
   b) `;`
   c) `|`
   d) `,`

3. The dot command (`.`) in matrix manipulation
   a) conducts element to element operations.
   b) ends an mfile.
   c) outputs the scalar value of the dot product.
   d) outputs the vector cross product.

4. The output of the last line is
   ```
   r=[1 3 -6;4 7 1; 5 9 10];
   n=length(r)
   ```
   a) `-6`
   b) `3`
   c) `9`
   d) `10`

5. The correct code sequence to solve the following system of linear equations is
   ```
   coef=[2 4 -1; 2 -2 7; 1 4 7];
   rhs=[3; 6; -2];
   ```
   a) `ukn=coef*rhs`
   b) `ukn=inv(coef)*rhs`
   c) `ukn=coef*inv(rhs)`
   d) `ukn=inv(rhs)*coef`

EXERCISES
Chapter 5
How Do I use Matrices

1. Given,

$$[A]=\begin{bmatrix} 5 & 2 & 4 \\ -2 & 3 & 1 \\ 7 & 2 & -1 \end{bmatrix}$$

$$[B]=\begin{bmatrix} 4 & -3 \\ 6 & 2 \\ -4 & 1 \end{bmatrix}$$

$$[C]=\begin{bmatrix} 6 & 9 \\ 5 & -2 \\ 1 & 4 \end{bmatrix}$$

   Using MATLAB, find
   a) B + C
   b) B – C
   c) inverse of A
   d) [A][B]
   e) det(A)
   f) transpose of (A)

2. Using matrices and MATLAB, solve for the variables x, y, z in the system of linear equations.

$$3x+5y-2z=1$$
$$2x-2y+7z=3$$
$$x+8y-4z=-6$$

   Use the `fprintf` command to display the solution to the system of equations. Include a brief description of the solution as well.

3. Given that the equation of a line is $y = mx + b$ where m is the slope and b is the vertical (y-intercept), use matrices to find the equation of the line that passes through the (x,y) data pairs: (1,6) and (4,10).

4. Given,

$$[P] = \begin{bmatrix} 4 & 0 & -3 & 7 \\ 9 & 7 & 4 & 2 \\ 0 & 1 & -9 & 6 \\ 3 & 2 & 7 & 1 \end{bmatrix}$$

Using MATLAB, find the

a) row and column dimensions using the `size` command.
b) norm of [*P*] (max column sum).
c) trace of [*P*].
d) inverse of [*P*], and name the matrix, `Q`.

For parts (a), (b) and (c), use the `fprintf` command to display the result. For (d) use the `disp` command to display `Q`.

5. Given the two vectors,

$$\vec{\omega} = [4 \quad 2 \quad 7]$$

$$\vec{r} = [2.5 \quad 4 \quad 1.3]$$

Using MATLAB, find the:

a) vector dot product.
b) vector cross product.
c) sorted vector of $\vec{r}$, and name the array, *r_sort.*

Use the `fprintf` or `disp` commands to display the appropriate solution(s).

MULTIPLE CHOICE TEST
Chapter 6
How Do I Plot In MATLAB?

1. The MATLAB command to make a plot is
   a) `figure`
   b) `fit`
   c) `plot`
   d) `pplot`

2. The dot (`.`) in MALTAB is used for
   a) element to element mathematical operating
   b) ending a command
   c) naming a figure
   d) requesting a colorful candy

3. The standard inputs for the MATLAB command `semilogx` are
   a) `(log(x),y)`
   b) `(x,y)`
   c) `(log(x),log(y))`
   d) `(exp(x),y)`

4. The interval between the points in the array `xx=[3: 0.1 :20]` is
   a) 0.1
   b) 3
   c) 10
   d) 20

5. The vector, `xp=[3: 0.5 :9]` yields ________ elements?
   a) 2
   b) 10
   c) 13
   d) 20

6. To plot $y=x^2$ from x = 3 to 7, the command sequence is

a)
```
x=3:0.1:7
y=x.^2
plot(x,y)
```
b)
```
x=3:0.1:7
y=x.^2
plot(y,x)
```
c)
```
x=7:0.1:3
y=x^2
plot(x,y)
```
d)
```
x=7:-0.1:3
y=x^2
plot(y,x)
```

EXERCISES
Chapter 6
How Do I Plot In MATLAB?

1. A rocket is horizontally strapped to the top of a sled and ignited. The position of this contraption is given as a function of time by

   $$s(t) = \frac{3}{50}t^3 + \frac{7}{30}t^2 - 5t \ (\text{ft}).$$

   Plot the position of the sled in MATLAB from 0 to 60 sec.

2. The kinetic energy of a system can be modeled as

   $$\text{KE} = \frac{1}{2}m\left(v^2\right),$$

   where

   KE is the kinetic energy $(\text{N}\cdot\text{m})$

   m is the system mass (kg)

   v is the velocity $\left(\frac{\text{m}}{\text{sec}}\right)$

   Plot the kinetic energy of a system vs. velocity in MATLAB. Use values of mass as 2 kg and take the range of velocity as 0 to 30 m/s.

3. For the duration of one year, the total sales profit for a turbine company are recorded. At the end of each month, the total profit (in millions of dollars) for that month is calculated and stored in MATLAB as an vector, `profit`.

   $$\text{profit} = [0.3 \quad 0.45 \quad 2.1 \quad 1.4 \quad 1.12 \quad 3.2 \quad 2.3 \quad 1.23 \quad 0.76 \quad 0.97 \quad 1.2 \quad 0.78]$$

   Using MATLAB graphing features, plot the profit vs. time (months). Also, using the `fprintf` command, output the total profit (in millions) for the year.

4. The velocity of a rocket is given by,

   $$v(t) = 2000\ln\left[\frac{14\times10^4}{14\times10^4 - 2100t}\right] - 9.8t \ , \ 0 \le t \le 30$$

   where v is given in m/s and t is given in seconds. Plot the velocity of the rocket as a function of time from 0 to 30 seconds. Use a loglog plot. The command for finding a natural log is `log` (see Chapter 8 or use MATLAB help).

MULTIPLE CHOICE TEST
Chapter 7
What Else Can I Do With Plots?

1. The command to add a title to a plot is
   a) `ptitle`
   b) `t`
   c) `title`
   d) `title,plot`

2. The `MarkerSize` command
   a) adjusts the overall size of the figure font.
   b) adjusts the size of plotted points.
   c) changes the aspect ratio of the graph size.
   d) changes the thickness of plotted lines.

3. To add a subscript, use the character(s)
   a) `\_`
   b) `\n`
   c) `^`
   d) `_`

4. The command `\it`
   a) creates italic font for all subsequent text.
   b) calls to life a creature from a swamp.
   c) creates a junction between plotted figures.
   d) creates italic font for all preceding text.

5. Two sets of data points and a function, coded in the order, `data_set_1`, `data_set_2`, and `function_1`, are plotted. The correct code sequence to create the appropriate legend is
   a) `legend('data set 1','data set 2','function 1')`
   b) `legend('function 1','data set 2','data set 1')`
   c) `legend(data set 1, data set 2, function 1)`
   d) Code sequence does not matter.

EXERCISES
Chapter 7
What Else Can I Do With Plots?

1. A rocket is horizontally strapped to the top of a sled and ignited. The position of this contraption is given as a function of time by,

   $$s(t) = \frac{3}{50}t^3 + \frac{7}{30}t^2 - 5t \ \ (\text{ft}).$$

   Plot the position of the sled in MATLAB from 0 to 60 seconds. Add a title (bold font) and axis labels (italic font) to the plot.

2. Plot the lift and drag forces exerted on an airfoil as a function of velocity. Use velocity values going from 0 to 45 m/s on a log-linear plot (log-scale on the y axis). The working fluid density (ρ) is 1.423 kg/m^3, the exposed airfoil area (A) is 129 m^2, and the coefficients of drag (C_D) and lift (C_L) are 0.178 and 0.896, respectively. Recall that the equations for drag and lift forces are

   $$F_D = \frac{1}{2} C_D \ A \ \rho \ V^2,$$

   $$F_L = \frac{1}{2} C_L \ A \ \rho \ V^2.$$

   Your plot should display an appropriate legend, title and axis labels and should include units. The line width of the two lines should be adequately sized.

3. The required specific input work (kJ/kg) for an insulated refrigerant compressor is found to be,

   $$w_{in} = h_{out} - h_{in}.$$

   where h_{out} and h_{in} have units of kJ/kg and correspond to the enthalpies at the exit and inlet of the compressor, respectively. The inlet enthalpy is always a constant value of 278.76 kJ/kg. On the other hand, the exit enthalpy will change as a function of exit pressure and temperature. The following data is collected:

   $$\text{Exit pressure (bar)} = [1.0 \quad 1.4 \quad 1.8 \quad 2.0 \quad 2.4 \quad 2.8 \quad 3.2]$$

   $$h_{out}\left(\tfrac{\text{kJ}}{\text{Kg}}\right) = [278.76 \quad 286.96 \quad 295.45 \quad 304.50 \quad 313.49 \quad 332.60 \quad 342.21]$$

   Plot the input work as a function of the the exit pressure, and show the data as points (use circles) on a standard linear plot. Be sure to add a figure title and axis labels, use increased marker size, and show a grid.

MULTIPLE CHOICE TEST
Chapter 8
How Do I Use Logarithmic and Trigonometric Functions?

1. The command for finding the natural log of a number is
   a) `ln`
   b) `log`
   c) `loge`
   d) `nlog`

2. The command for finding the exponential function of a number is
   a) `e`
   b) `e^`
   c) `exp`
   d) `exp^`

3. The command to find the value of sin(*a*) where *a* is 34°, is
   a) `sin(34)`
   b) `sine(34)`
   c) `sin((34*180)/pi)`
   d) `sin((34*pi)/180)`

4. To find the value of a logarithm of base 10 the command is
   a) `lb10`
   b) `log`
   c) `log10`
   d) `logb10`

5. The command `acos`
   a) determines if the cosine value can be evaluated.
   b) evaluates the cosine of an angle in degrees.
   c) evaluates the cosine of an angle in radians.
   d) evaluates the inverse cosine of an argument.

6. The `sind` command
   a) determines if the sine value can be evaluated.
   b) evaluates the inverse sine of an argument.
   c) evaluates the sine of an angle given in degrees.
   d) evaluates the sine of an angle given in radians.

EXERCISES
Chapter 8
How Do I Use Logarithmic and Trigonometric Functions?

1. Given that $a = 7,\ b = 2,$ and $c = 11$, using MATLAB find the values of
   a) $\log_{10}(b)$
   b) $b\ln(c)$
   c) $e^{-\frac{a}{2}}$
   d) $\log_2(a)$

   Output each solution to the command window, and check your results using a calculator.

2. The approximate value of e^x (exponential function) can be found by using a finite number of terms of the following infinite Maclaurin series,

   $$e^x \approx 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$$

   for all x.

   Complete the following using $x = 2.3$:
   a) Compare the output of the first 3 terms for the Maclaurin series for exponential function against the MATLAB output for the exponential function.
   b) Redo part (a) using first 6 terms of the Maclaurin series.

   Make sure to use the `fprintf` statement or `disp` command to display your program outputs in the command window.

3. Given are two angle measurements,

   $$\theta_1 = \frac{\pi}{8} \text{ and } \theta_2 = 34°,$$

   and a length measurement of 4 inches, x. Complete using MATLAB:
   a) $\sin(\theta_1)\cos(\theta_1)$
   b) $x\tan(\theta_1)$
   c) $\cos^{-1}(x)$
   d) $7\csc(\theta_2)$

   Output each solution to the command window and verify your results with a calculator. Make sure to use the `fprintf` statement or `disp` command to display your program outputs in the command window

4. The approximate value of $\sin(x)$ can be calculated using a finite number of terms of the following infinite Maclaurin series

$$\sin(x) \approx x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots$$

for all *x*.

Complete the following using $x = 38^{\circ}$:

a) Compare the output of the first 3 terms of the Maclaurin series provided, against the MATLAB output for the sine command.

b) Redo part (a) using the first 5 terms of the series.

Make sure to use the `fprintf` statement or `disp` command to display your program outputs in the command window.

5. The mechanical components of a certain suspension system dynamically respond to an applied force by vibration. The actual position of the center of mass of the system as a function of time is given by,

$$x(t) = Xe^{-\xi\omega_n t}\left(\cos\left(\sqrt{1-\xi^2}\,\omega_n t\right)\right).$$

Ideally, the center of mass would follow the following position function,

$$x(t) = Xe^{-\xi\omega_n t}$$

Given that

$X = 2,$

$f_n = 1.3,$

$\omega_n = 2\pi f_n,$

$\xi = 0.1,$

plot the actual and the ideal position of the system as a function of time. Use a legend, give axis and graph titles, and use reasonable line thicknesses and symbols. Plot the position for time from 0 to 8 seconds in a single plot where the horizontal axis is the time and the vertical axis is the position.

MULTIPLE CHOICE TEST
Chapter 9
How Do I Use Symbolic Characters?

1. If one was going to write `y=3*x` in an mfile, the variable(s) that would need to be declared as symbolic is(are)
   a) `x`
   b) `y`
   c) both `x` and `y`
   d) either `x` or `y`

2. The `clear` command
   a) clears the command window.
   b) empties the mfile.
   c) turns a symbolic character off.
   d) restarts the symbolic command.

3. Given the following code:
   ```
   m=2;
   syms m c
   e=m*c^2;
   e
   ```
   the output of the **last line** in the command window is
   a) `e=2*c^2`
   b) `e=m*c^2`
   c) `e=m*4`
   d) `???Undefined function or variable...`

4. The symbolic character that will cause problems when used in an mfile is
   a) `ex`
   b) `sin`
   c) `tt`
   b) `x`

5. The output of the last line of the program
   ```
   y=5
   y=3*x
   ```
   is
   a) `3x`
   b) `15`
   c) `y`
   d) `???Undefined function or variable 'x'.`

EXERCISES
Chapter 9
How Do I Use Symbolic Characters?

1. In a single mfile, display the expression in all the parts below in the command window.
   a. $y = \frac{2}{3}x^2 + x + x^{1/2}$
   b. $z = \dfrac{x^2 y}{x+1}$
   c. $P = \dfrac{mRT}{V}$
   d. $x = \dfrac{M_v}{(M_v + M_l)}$

2. In most cases, the weight w of an object is determined by the mass of the object m and the acceleration acting on the body of the object a given by the relationship
   $w = m\,a$.
   Display the general expression to find the weight of a body.

3. The brake power of an internal combustion engine is found by
   $P = r \cdot T$
   where
   $P =$ Power (Watt)
   $r =$ Rate (radian/sec)
   $T =$ Torque (Nm)
   and the engine torque is given by
   $T = 0.62\,r$.
   Using MATLAB
   a. display the general expression for the brake power generated by the engine,
   b. find the value of the brake power when r is 350 rad/sec,
   c. plot power vs. rate with values of r from 0 to 630 rad/sec. Use appropriate labels, titles, etc., as required to describe the plot.

4. The acceleration of a point on a body is comprised of four components: the tangential, normal, sliding, and Coriolis. Assuming that sliding and Coriolis effects of acceleration are zero, the tangential ($a_{\tan}$) and normal (a_{normal}) components of acceleration can be combined as

$$a_{total} = \sqrt{a_{\tan}^2 + a_{normal}^2}$$

where

$$a_{\tan} = 2\sin\left(\frac{1}{2}t\right) + t^2$$

$$a_{normal} = \frac{\left(\frac{1}{3}t^3 - 4\cos\left(\frac{1}{2}t\right)\right)^2}{300}$$

Display the equation for the total acceleration of the body in the command window (use *t* as a symbolic character). Find the value of the acceleration of the body when *t* =4.3 seconds.

MULTIPLE CHOICE TEST
Chapter 10
How do I Solve a Nonlinear Equation?

1. The MATLAB command for solving a nonlinear equation is
   a) `fsolved`
   b) `nonlinear`
   c) `solution`
   d) `solve`

2. The MATLAB command for solving a single nonlinear equation has ______ input variables
   a) 1
   b) 2
   c) 3
   d) 4

3. To solve $x^2+2x=0$, the MATLAB command is
   ```
      syms x
   a) solve('x^2+2x=0',x)
   b) solve('x^2-2x',x)
   c) solve('x^2+2*x=0',x)
   d) solve('x^2+2*x=0')
   ```

4. To solve $3x^2+2x=5$, the MATLAB command is
   ```
      syms x
   a) solve('3*x^2 + 2*x + 5', x)
   b) solve('3*x^2 + 2*x = 5', x)
   c) solve('3*x^2 + 2*x + 5 = 0', x)
   d) solve('3*x^2 + 2*x = 5, x')
   ```

5. The command to convert an exact number to a decimal format is
   a) `approx`
   b) `dec`
   c) `double`
   d) `round`

6. The output solutions for a single nonlinear equation given by the `solve` command
   a) gives only one solution to the equation.
   b) gives only the physically acceptable solution(s).
   c) provides the solutions as separate outputs.
   d) stores solutions in a single vector.

EXERCISES
Chapter 10
How Do I Solve a Nonlinear Equation?

1. Use the solve command to find the solution to $3x^2 + 2x = 5$.

2. Given that the value of the two variables, a and b can be changed, set up the equation $ax^2 + 2x = b$ so that it can solved for any real values of a and b.

3. You are working for 'DOWN THE TOILET COMPANY' that makes floats for ABC commodes. The floating ball has a specific gravity of 0.6 and has a radius of 5.5 cm. You are asked to find the depth to which the ball is submerged when floating in water (Figure 10.1e).
   The equation that gives the depth x to which the ball is submerged under water is given by
   $$x^3 - 0.165x^2 + 3.993\times10^{-4} = 0$$
   Find the depth x to which the ball is submerged under water.

   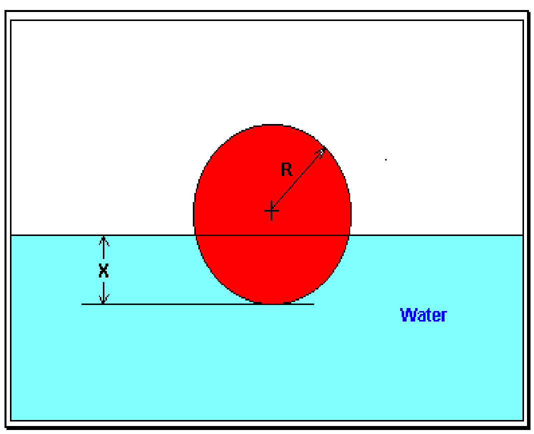

   Figure 10.1e – Corresponding to Exercise (3); floating ball in water.

4. You have a spherical storage tank containing oil (Figure 10.2e). The tank has a diameter of 6 ft. You are asked to calculate the height, h, to which a dipstick 8 ft long would be wet with oil when immersed in the tank when it contains 4 ft^3 of oil. The equation that gives the height, h of the liquid in the spherical tank for the above given volume and radius is given by
   $$f(h) = h^3 - 9h^2 + 3.8197 = 0$$
   Find the height, h to which the dipstick is wet with oil.

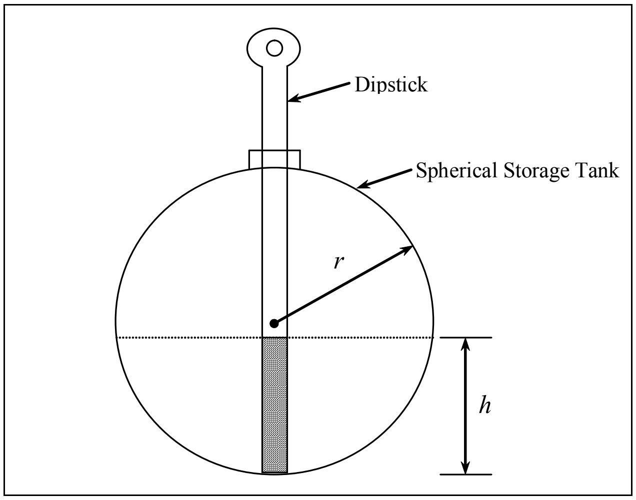

Figure 10.2e – Dipstick inside spherical tank which contains some oil.

5. You are making a bookshelf to carry books that range from 8½" to 11" in height and would take up 29" of space along the length. The bookshelf material is wood, which has a Young's Modulus of 3.667 Msi, a thickness of 3/8" and width of 12". You want to find the maximum vertical deflection of the bookshelf. The vertical deflection of the shelf is given by

   $$v(x) = 0.42493\times10^{-4}x^3 - 0.13533\times10^{-8}x^5 - 0.66722\times10^{-6}x^4 - 0.018507x$$

   where x is the position along the length of the beam (Figure 10.3e). To find the maximum deflection we need to find where

   $$f(x) = \frac{dv}{dx} = 0$$

   and conduct the second derivative test.

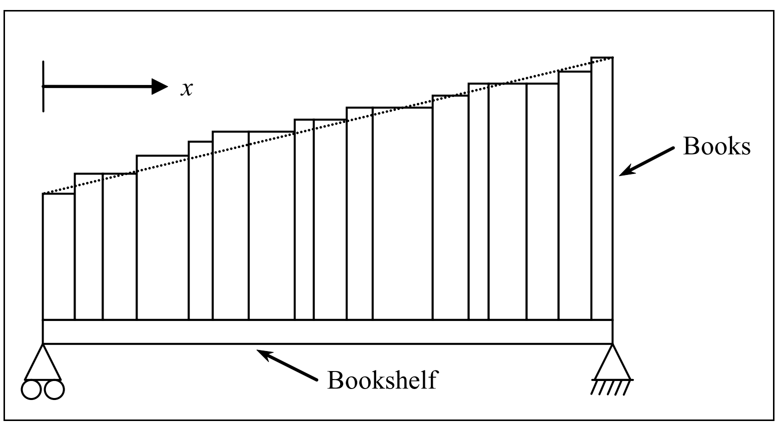

Figure 10.3e – Schematic of bookshelf used in Exercise 5.

The equation that gives the position, x where the deflection is extreme (minimum or maximum) is given by

$$-0.67665\times10^{-8}x^4 - 0.26689\times10^{-5}x^3 + 0.12748\times10^{-3}x^2 - 0.018507 = 0 \ .$$

Find

a. the position x where the deflection is maximum, and
b. the value of the maximum deflection.

6. A trunnion has to be cooled from a temperature of $80°\text{F}$ before it is shrink fitted into a steel hub (See Figure 10.4e). The equation that gives the temperature T_f to which the trunnion has to be cooled to obtain the desired contraction is given by

$$f(T_f) = -0.50598\times10^{-10}T_f^3 + 0.38292\times10^{-7}T_f^2 + 0.74363\times10^{-4}T_f + 0.88318\times10^{-2} = 0$$

Find the roots of equation to find the temperature T_f to which the trunnion has to be cooled. Choose the physically acceptable root of the equation.

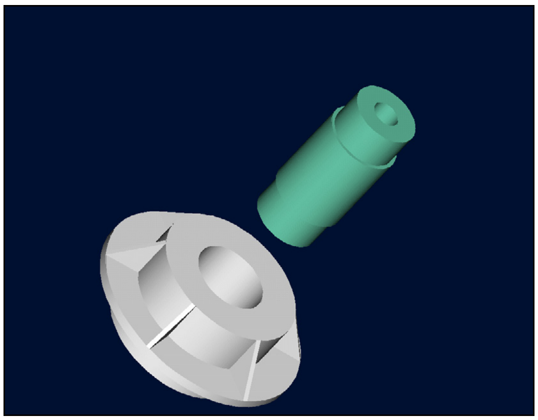

Figure 10.4e – Trunnion and hub shown prior to shrink fitting for Exercise 6.