One reason why spreadsheet programs like Excel are so useful for engineering calculations is that the functions appearing in models of circuits and other linear systems are included in the spreadsheet function library. Take the trig functions, for example. The sine, cosine, and tangent functions are available, with input arguments in radians. If your argument cell, say D6, has an angle value in degrees, then the function \( \text{radians}(D6) \) returns the value in radians. Thus the formula \( \text{=sin(radians(D6))} \) displays the sine of the angle. Another handy function for trig work is \( \text{PI()} \), a function with no argument. This function returns a very accurate value of the trig constant \( \pi \).

Open a new worksheet and title it “Plotting Some Engineering Functions”. Leave space for a section heading for the first chart and for column headings. Create a line graph of one full period of the cosine function, from 0 to \( \frac{\pi}{2} \). To do this, use the \text{row} function to generate the values 20, 2, 1, 0 and the cosine and \text{PI} functions to generate values

\[
\cos\left(\frac{n \cdot \pi}{10}\right), \quad n = 0, 1, 2, \ldots, 20.
\]

in a second column. Fill in the section heading to identify the chart and add column headings.

The inverse trig functions return an angle in radians. The angle whose sine is in E9 is, in degrees, is computed by a formula which computes the inverse sign in radians and another function which converts radians to degrees. The argument of a function is input, while the function name in the formula represents output. Find the functions and nest them properly in the cell formula. Corresponding to a value between –1 and +1, only one of many possible values is returned by the inverse function. The value returned is called the principal value. In a second chart, display the principal values of the inverse sine function. For this chart, generate 21 equally spaced values from –1 to 1 by transforming the numbers 0, 1, ..., 20 in the first column, and plot the arcsine values in degrees.

The exponential function (\text{EXP}) often appears in modeling the behavior of circuits. For example, the electric charge from a battery building up in a capacitor to a maximum value or discharging when the battery is switched out of the circuit. Consider the 21 values 0, …, 20 to be units of time \( t \), and generate values for \( 1 - e^{-at} \) and \( e^{-at} \), both depending on a single cell value \( a \) in which you have placed an initial value. Set up a single chart displaying both functions plotted against the 21 time values. Now vary the value of \( a \) to obtain a chart showing clearly how the values approach 1 and 0 as time passes.

Logarithm functions, are used to compress a large range of values to a more manageable size. For example, frequencies of sound or electromagnetic waves (waves passing per second) have a large range of values. The logarithm of the frequency is used
for the x-axis in plotting the intensity of signal at different frequencies. Logarithmic scales are used also when the y-axis values have too large a range for convenient representation. Examples would be sound and earthquake magnitudes. Sound intensity is measured in decibels. To convert a number to decibels, take the logarithm to base 10 and multiply by 20. Do a small experiment with decibels on your worksheet. Place a set of positive numbers on a row, increasing from left to right to a very large size. On the next row display the corresponding decibel values. Look up the log to base 10 by clicking the Paste Function symbol on the formula toolbar and selecting the math and trig section of the dialog box. Select LOG10 in the list to the right. Comment on how the values are compressed to a manageable range.

Some functions have a cell range, rather than a single cell, as an input argument. A frequently used example is the sum function, which returns the sum of all cell values of the range. Use the sum function here to place the sum of the first column 0,1,…,20 under the column.

Complete your worksheet by selecting another function from the math and trig section of the Paste Function dialog box and illustrating that the use of that function on the worksheet. Be sure to explain what function you have selected, and what formula you are using to illustrate it.