Physics 309
Making *Mathematica* Do Work for You

Introduction

These exercises develop further skills you learned in the first set. The goal is to learn how to use *Mathematica* on problems you're interested in. So refer extensively to the on-line help to ensure that you understand what you're doing in each of these exercises.

Practice with *Mathematica*

1. Evaluate $\sqrt{10}$ to 8 decimal places.

2. Evaluate π to 500 decimal places.

3. Factor the expression $(x+y)^2 + 7(3+x)(x+y)$.

4. Evaluate the following integral – first analytically, then numerically. In each case, assign a name to the statement in which you perform the evaluation.

$$\int_0^{\pi} \sqrt{1-\cos x}\, dx$$

Are your answers the same? Use your named results to determine the number of significant figures of agreement between the analytic and numerical answers.

5. Use **`Solve`** to solve the following equation:

$$x^2 + 3x = 7$$

Use an assignment statement to name the solution **`soln`**. Then pipe this solution into **`N`** to make *Mathematica* give you a numerical result. Notice that the solution is a list consisting of two elements, each of which is itself a list containing a *transformation rule*.

6. Plot the polynomial $x^2 + 3x - 7$. Use *Mathematica's* built-in mechanism for finding coordinates on a plot to determine whether your answers from the previous exercise are correct.

7. Use **`FindRoot`** to find the roots of the polynomials $x^2 + 3x = 7$. As starting values, give *Mathematica* $x = 10$ and $x = -10$. Are these starting values close enough that *Mathematica* can find the right answer?

8. Prepare a 3D plot of the function $\sin(x)\sin(3y)$ for a sufficiently large range of values of x and y to show clearly the periodic structure of this function (but not so large a range that you can't see the oscillations). Assign the name **`plot3D`** to your plot. Use the option **`PlotPoints → 30`** to clarify your plot.

9. Prepare a contour plot of $\sin(x)\sin(3y)$. Try the option **`Contours → 20`**. Do you think this improves the appearance of your plot?[1]

10. Define a function **`cubeRoot[x]`** which evaluates the cube root of its argument. Use your function to evaluate the cube root of 27. What happens when you use as an argument to your command the expression $9 + 4x^2$?

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[1] A contour plot shows the level curves of a function of two variables. A level curve of a function $f(x, y)$ is a curve of the form $f(x, y) = c$ for any constant c. You can show particular level curves by specifying the value of c with the option **`Contours`**.