Differential Equations with Linear Algebra
Math 3280
Lab #1: Introduction to *Mathematica* Software
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Directions: Turn in a short written lab report dealing with the tasks below. Your report should include goals, description of the procedures you used in the lab, *Mathematica* output with comments, and conclusions. The writeup may be typed within *Mathematica*, done with hand comments neatly added to *Mathematica* output, or done with a word processor. Grading: Goals (G) 1, Procedures (Pro) 1, *Mathematica* tasks (Ma) 5, Conclusions (C) 1, Presentation and Organization (P+O) 2, Total 10.

1. *Mathematica*. This software is a huge multipurpose computational software package. We will use a small set of its capabilities in this class. As with any computer software, there is a necessary startup effort. The goal is to have you learn enough about *Mathematica* to be able to aid you in performing computations not only for Differential Equations and Linear Algebra, but for many of your math, science and engineering courses at UMD, and possibly beyond in your career.

   Sources of help: online Lab 1 *Mathematica* Hints, instructor, TA, fellow students, lab consultant, HELP menu, Welcome to Wolfram Mathematica 7 links, especially Get a quick overview, Learn with guided examples, Function Navigator, Virtual Book, and Documentation Center Home.

   (a) "Open" *Mathematica*. Depending on the machine and lab, you may need to search through "All Programs" to find it. Ask if you have trouble.

   (b) Numerical computations. Use *Mathematica* to do the Algebra computations on the Lab 1 task sheet. Remember to type SHIFT-RETURN or ENTER to tell *Mathematica* to evaluate an expression you have typed in.

   (c) Insert a heading, including your name(s), at the beginning of the notebook. You will need to change the Format Style of your heading (and any comments) to anything other than Input (using the Format → Style → ...).

   (d) Save your current *Mathematica* "notebook" to your UMD account. Note: If you merely save a file on the machine's hard disk, there is no guarantee it will still be there when you come back. It is STRONGLY recommended learn how to save it on your UMD account. (Ask the lab consultant on duty for help.) Shut Down the PC/Mac, restart it, open your saved notebook, and reevaluate all your input commands (using Kernel → Evaluation → Evaluate Notebook).

   (e) Do the Calculus tasks on the Lab 1 Tasks sheet.

   (f) Make sure your notebook is up to date by again choosing Evaluate Notebook and checking to see that the output is what you expected.

   (g) Print out your notebook. (You may want to complete the lab writeup before printing.)

Lab 1 Tasks

1. Algebra computations. Compute the following expressions.

   (a) $2 + 2$

   (b) $\frac{2*3^2}{10}$

   (c) a representation for the exact value of $\sqrt{8}$ using the Sqrt function (Hint: Look up the format for Sqrt using Help → Documentation Center → Mathematics and Algorithms → Mathematical Functions → Elementary Functions.)

   (d) a representation for the exact value of $\sqrt{8}$ using the Arithmetic and Numbers section of the Basic Math Input Palette (Palettes → Other → Basic Math Input).

   (e) the numerical value of $\sqrt{8}$. (Hint: N[blob] produces the numerical value of blob.)

   (f) the numerical value of e to 10 digits. (Hint: Use N[E,10] or "Search" for the N command using the input window on the Help → Documentation Center.)

   (g) Solve $x^2 = 1$. Look up the Solve command. Note the use of the double equals sign to distinguish from an assignment like x=3 which uses a single equals sign. Example: sln=Solve[$x^2 == 1, x$]. Note that *Mathematica* gives a list of solutions. (Lists are contained in "curly" brackets.) Type in sln[[2]]. Explain the output you get. (Recall that double square brackets are used for subscripts.)

   (h) Solve the system of equations $y - 3x = 2$ and $2y + x = 1$ for x and y. (Look up the Solve command on the Help → Documentation Center. Example: Solve[$\{y - 3x == 2, 2y + x == 1\}$, $\{x, y\}$]. Notice the use of the braces so that the solve function takes on only two arguments, whether we are solving one equation or a system of equations.

2. Calculus tasks.

   (a) Compute the derivative of e^{4x} using the D command directly: D[$E\hat{}(4x)$, x] Note: The second argument tells the variable with respect to which we are taking the derivative. Why are the parentheses around $4x$ necessary?

   (b) Compute the derivative of e^{4x} using the derivative template from Basic Math Input Palette. The template uses partial derivative notation for its derivatives: $\partial_x f(x)$ denote the (partial) derivative of f with respect to x.

   (c) Compute the derivative of e^{4x} by assigning the function to a new variable, say y ($y = E\hat{}(4x)$), and then using the command D[y, x] to differentiate.

   (d) Compute the derivative of e^{4x} by defining the function with a replaceable variable via $f[x\_]:=E\hat{}(4x)$, and then using $f'[x]$ for its derivative. See more on defining functions in the *Mathematica* Hints link from the course web page.

   (e) Compute the second derivative of e^{4x} using any method you can find.

   (f) Compute $\int e^{4x} dx$. (Hint: Look up integrate, or use the integral template from the Basic Math Input Palette.)