Lab 2
CS 122 Computation Lab II
Winter 2009
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Lab 2 Directions and Problems

1. The instructor will present a brief overview of this week's new concepts and Maple features, and provide commentary on the lab required activities. (20-25 minutes)

**Notes**
- A verification sheet will be passed out for each group of lab partners.

2. With your lab partner(s), work on part 0, below if you did not complete it last time. (40 minutes)
- Form a group. Group members should introduce themselves to each other if they haven't already met.
- All of the partners should log onto a computer.
- Work read and attempt the problems individually, but stop frequently to compare results and help each other out. Eventually, the graders will be looking for a single collection of answers from the group that everyone in the group can explain. If you are in a room with computer projectors, then please prepare a single computer which can be used to present the group's results to the grader by projection. In most rooms, it's difficult for the grader to stare over your shoulder at results on a screen. Furthermore, the other members of the group also have to stare over a shoulder to see something that they may be asked to talk about.
- Write down the selected answers on the verification sheet. When you are finished with part 0, have a staff member come over to sign the verification sheet for you. Be prepared to show your work to the staff member, and to explain how you got your answers. This is also the opportunity to clear up any questions or uncertainties you may have at this point.

**Problems-- Part 0**

Part 0 is a replay of Lab 1 Part 2, since some people didn't get to finish it the last time. We don't always expect to give this offer, but if you did the work last time and can retrieve and have your entire team be able to demo and explain the lab, you can get credit again for doing it. There is a special verification sheet for part 0.

**Problem 0.1**

A sphere of unknown radius $x$ consists of a spherical core and a coating that is $\tau$ cm thick. The
volume of the coating and the volume of the core are the same.

(a) Find the radius and the volume of the sphere when $\tau = 1$. Display the information for both the radius and the volume as a three digit numerical approximation. You can look up the formula for the volume of a sphere (if you don't recall it) in Maple's on-line help by typing in an obvious keyword.

(b) Write a function called $sphereVolume := (r) \rightarrow \ldots$ that computes the volume of the sphere given a value of its parameter $r$. Test it for $r=1$ to see that it gives the correct result.

(c) Write another function called $coatingVolume := (r, \tau) \rightarrow \ldots$ that computes the volume of the coating for a given radius and value of $\tau$. Test your function for $\tau = 1$ and the value of the radius that you got from solving (a). If the solution being produced by $solve$ is a piecewise expression, then you should add the phrase $assuming \ tau>0$ after it to simplify the piecewise expression. Verify that the $sphereVolume$ and the $coatingVolume$ are the same.

(d) Enter $solve(coatingVolume(r,1)=sphereVolume(r),r)$. Note that the form of the answer is a piecewise expression.

(e) Now enter $solve(coatingVolume(r,1)=sphereVolume(r),r) assuming \ tau>0$. Note that the assuming has simplified the solution.

(f) Now enter $eval(r, solve(coatingVolume(r,1)=sphereVolume(r),r) assuming \ tau>0)$ Notice that this is just the number. We are taking the set that solve gives and evaluating the variable $r$ for the equation specified by the $solve$ solution. This is just another way of getting at the right hand side of the equation.

(g) Write two functions, $sphereVolume := (\tau) \rightarrow \ldots$ and $radiusSolution := (\tau) \rightarrow \ldots$ that express the volume of the sphere and the radius of the sphere.

(h) Create a plot of $\tau$ versus volume and radius for $\tau$ between .1 and 1.

Problem 0.2

We want to better visualize the sphere and its coating from problem 2.1 for various values of $\tau$.

(a) Enter the command

```maple
plottools[sphere]([0, 0, 0], 1, color = pink, style = patchnogrid)
```

This should draw a sphere of radius 1 whose center is at the three dimensional coordinate (0,0,0). Note that this is a three dimensional plot compared to the two dimensional ones we have previous generated.

The plottools package has a component called $sphere$. plottools[sphere] is a procedure whose first parameter is a list describing a three dimensional coordinate for the center of the sphere. The second coordinate is the radius of the sphere. Other parameters are descriptions to plot.
(b) Now enter the commands

```plaintext
sphere1 := plottools[sphere]([0, 0, 0], 1, color = green, style = patchnogrid) :
sphere2 := plottools[sphere]([0, 0, 0], 1.1, color = pink, style = patchnogrid, transparency = .9) :
plots[display]([sphere1, sphere2], axes = boxed)
```

This should create a single plot with nested spheres, one slightly larger than the other. The outer sphere should be translucent (if we had set transparency=0 it would be completely opaque; setting it to 1 would make it invisible).

(c) Create a function `dcs := (r, tau) -> ....` that takes a particular value of `r` and `tau`, figures out the radius that solves the problem 2.1, and then draws both the inner sphere (in green) and the coating (in pink). In other words, `dcs(1, 1)` should produce a picture like this:

(d) Create an animation of how the sphere and coating change as `tau` changes from .1 to 5. As explained in section 6.7 of the chapter readings, you can create an animation by creating a list `L` of plots and then doing `plots[display](L, insequence = true)`. If you have a function `dcs` and a function `radiusSolution`, then
[seq(dcs(radiusSolution(tau),tau),tau=.1..5,.1)] will produce such a list of plots. As explained in section 5.11, the seq function if given three parameters, will use the third parameter as an increment between values of tau. In this case it will produce a list of plots with tau= .1, .2, .3, .4, .... to 5.0.

3. With your lab partner(s), work on part 1, below (40 minutes)

**Problems -- Part 1**

With File->New->Document create a new document. File->Save As, and save the blank document as *Lab2Part1*. Then use this document to do your scratch work for the Part1 problems.

In this part we are going to try out simple things with code edit regions and while statements. The objective for the most part is just to imitate and get the same effects as the demonstrator. Since this is practice for when you will create all the code yourself, we are asking you to enter code by typing rather than by copying and pasting the model. In Problem 1.2 you will be asked to modify a working program to do something else. You will have to figure out how to do that on your own from your understanding of the original computation.

**Problem 1.1**

a) Position your cursor in a blank worksheet and create a code edit region by Insert->Code Edit Region on the Maple menu toolbar. Set the region size to 500 x 300 by the right-click->Component Properties.... (on Macintosh, control-click->Component Properties). Enter the code from Figure 11.1.1 exactly as it appears. Check it carefully for punctuation and indentation. When you are satisfied that things are accurate, enter control-E (on Apple command-E), or right-click->Execute Code (on Macintosh, control-click->Execute Code). The result of your execution should look like this:

```maple
# Problem 1.1
#initialize variables
i := 1;
val := .3; #evaluation point
term := (val^i)/i!; # a term to compute
print("term is", term); #message
s := term; #s has a copy of the term
 tol := 10e-7; #A small value.
```

1
0.3
0.3
b) Now reproduce the entire computation of Example 11.2.1.1. You should see the same output as listed in the readings.

The grader will check that the output is the same as the Example, as well as following the model style for line spacing and commenting, and indentation.

As the readings explain, the Example, is a demonstration about how you can get a fairly accurate approximation to a function such as $\sin$ or $\log$ evaluated for a specific value of $x$ by adding together the first few terms of a sum. (The sum's justification comes from what at Drexel is called "Calculus III".-- series.) The technology behind the functionality of pocket calculators, or Maple's own approximation features, is derived from this kind of mathematics. A lot of floating point technical calculation used in professional practice (equation solving, integration, solution of differential equations) is controlled by "while" repetition.

\section*{Problem 1.2}

a) We want you to modify the example in Section 11.2.3 of the course readings to compute:

$$e^x = 1 + x + \frac{1}{2} x^2 + \frac{1}{6} x^3 + \frac{1}{24} x^4 + \frac{1}{120} x^5 + \ldots$$

for $x = -.1$, until the terms become less than $10^{-9}$ in magnitude.

Observations: the initial coefficient of the term is 1. The initial $x$ power is 1. The way to get the next $x$ power is to multiply the previously computed $x$ power by $x$. The way to get the next coefficient is to multiply the previously computed coefficient by $c$, where $c$ is incremented by one each time through the while loop.

As with the Example, print out the successive values of the term, and the sum for $x=.2$, until the absolute value of the term becomes less than $10^{-10}$.

b) Copy your code into a new code region. Modify the code so that as well as doing the computation, the results are stored in a data structure (a table,) to store the successive values of the terms. Using the table, and the indices function to count how many elements are in it (see Example 10.2.1).

Do a plot point of $i$ (the term number: 1,2,3,4) with the magnitude (absolute value) of the term. From the graph, how many terms would you expect to have to compute to generally get an approximation accurate to three digits?

4. Save your worksheets, on Blackboard and/or via email to yourself. We will need some of the results next time, so you should put the .mw files somewhere you can
retrieve them. You also get a point on the verification sheet for doing this.

5. If you have sufficient extra time, work on the extra credit problem, below.

6. Hand in the signed verification sheet. You don't get credit for the lab without doing this. The lab staff will give you permission to leave the lab after you do this. You can get partial credit for the lab if a portion of your work is verified.

Notes

Final grades for the course will be curved if necessary, so don't fret excessively if you don't finish but it looks like others are in the same shape. However, you should try to learn the material you don't complete in lab so that you can pass the quiz and be ready for the next lab. Computer work at this introductory level introduces a lot of ideas and concepts that appear pervasively in subsequent work. The plus side is that you'll probably see next time more of what you worked on this time, so you'll have another chance to practice and improve. The down side is that you can't ignore tough details and hope that little will depend on mastering them in the future.