Phy 329: Computational Physics **Homework 2** **Due: Friday, September 18, 11:00am**

Important: *The following assignment requires working with the* `xmaple` *graphical interface to produce* Maple *worksheets as well as preparing source code for* Maple *procedures in plain-text files which can be input into* `maple` *or* `xmaple` *via the* `read` *command. To complete the assignment, you* must *use* `xmaple` *and* `maple` *on the SGI machines—the version of* Maple *installed on the Linux machines is not up to date. Note that since* `xmaple` *is an* `X`*-application, you can run it on* `einstein` *and have the results displayed on any machine which supports* `X`*. In particular, I recommend that you use the machines in the PMCL to complete Problems 1 and 2—if you use one of the Linux machines as your display, note that there is a very annoying bug in the way the Linux machines currently interact with* `xmaple` *running on the SGIs:* **neither the `backspace` nor `delete` keys work as a destructive backspace, you must use `<ctrl>-H`**. *Problems 3, 4 and 5 do* not *require the use of the worksheet interface (GUI), and you should thus be able to complete them from any shell running on* `einstein`*. Please follow all instructions carefully, and ensure that all requested files are in their correct locations in your SGI account (with their correct names!) when you have completed the assignment. Finally, as always, let me know immediately if there is something which you don't understand, or if you encounter serious problems with any part of the assignment.*

Problem 1: Using Chapter 2 of the *Maple V Learning Guide*, make and save a facsimile of the *Maple* worksheet I went through in class on September 4th and 9th. Note that a Postscript version of my worksheet is available on-line via the *Class Notes* web page—please refer to that document as well as the *Learning Guide* itself while doing this exercise. You are to work though Chapter 2 *in its entirety*, essentially entering everything which follows a *Maple* prompt (`>`) into your worksheet. Note, however, that there are two examples which do not work as documented in the *Learning Guide* (the assignment of a value to `Pi`, and the first use of `simplify` with a *side relation*.) You should omit these examples, as I did. Your worksheet should include annotations corresponding to the various sections and sub-sections of the Chapter, as mine does. Observe that complete instructions for adding comments, headings, titles, etc. are available via *Maple*'s on-line help facility. (For example, bring up the main help window, select *Worksheet Interface*, then *Documenting Your Work*, then *comments*.) Save the worksheet in the file `~/hw2/a1/the.mws` on your SGI account. Note that `.mws` is the standard extension for `xmaple` worksheet files. You need to do this question using the GUI (i.e. using `xmaple`) and you are warned that it may take *a few hours* to complete—I advise you not to leave this exercise to the last minute. I also advise you to develop the habit of saving your work frequently (by typing `<ctrl>-S`, for example) since, in my experience, the current version of `xmaple` is somewhat prone to crashing.

Problem 2: Create a worksheet called `~/hw2/a2/the.mws` in which the following computations have been performed:

$$\frac{d^3}{dx^3}\left(\sin(x)\cos(x) + \exp(\tanh(1/x))\right) \tag{2.1}$$

$$\int \frac{x^3+4x^2+6}{x^2-1}\,dx \tag{2.2}$$

$$\int_{y=-3}^{y=3}\int_{x=-2}^{x=2} \frac{x^2+2xy+y^2}{x^2-y^2}\,dx\,dy \tag{2.3}$$

$$\text{Taylor series about } x=0, \text{ up to and including the } O(x^{10}) \text{ term, of } \exp(\sin(x)+\cos(3x)) \tag{2.4}$$

Problem 3: Write *Maple* procedures as follows:

- `lreverse := proc(l::list)` $\cdots$
  `reverse` returns a list in which the elements of its argument `l` appear in reverse order:

```
> lreverse( [1,2,3,4] );
        [4, 3, 2, 1]
```

- `ljoin := proc(l1::list, l2::list))` ···
  `ljoin` returns a list which contains the elements of `l1` followed by the elements of `l2` (the original orderings of elements of both lists is maintained):

```
> ljoin( [1,2,3,4] , [10,11,12,13]);
      [1, 2, 3, 4, 10, 11, 12, 13]
```

- `lprod := proc(lnum::list)` ···
  `prod` returns the product of all elements in the list:

```
> lprod( [2, 3, 6] );
      36
```

  If `lnum` is the null list, `lprod` should call `ERROR('argument is null list')`.

Ensure that your procedures are as "bullet-proof" as possible; test them thoroughly with various input—invalid as well as valid—including null lists (`[]`). Note that the *only* place that a null list should be treated as an invalid argument is in `lprod`. All three procedure definitions should be adequately commented, and must be prepared in a single *Maple* source file (plain text file) called `~/hw2/a3/procs`. I must be able to read `~/hw2/a3/procs` into a `maple` or `xmaple` session using the `read` command. I will test your procedures with my own input.

Problem 4: Consider the series s_1, s_2 and s_3 as defined in class:

$$s_1 = 1 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5 + \cdots$$
$$s_2 = 1 + b_1 x + b_2 x^2 + b_3 x^3 + b_4 x^4 + b_5 x^5 + \cdots$$
$$s_3 = 1 + c_1 x + c_2 x^2 + c_3 x^3 + c_4 x^4 + c_5 x^5 + \cdots$$

Use *Maple* to compute the coefficient c_5 in terms of the a_i and b_i for the following three cases:

- $s_3 = 1/s_1$
- $s_3 = s_1 s_2$
- $s_3 = s_1/s_2$

Fully document your work (including any procedures you define) in a *Maple* worksheet file `~/hw2/a4/the.mws`

Problem 5: Implement a *Maple* procedure that computes the unique polynomial (the Lagrange interpolating polynomial) of degree $n-1$ which passes through $[x_i, f(x_i)],\ i = 1 \cdots n$. Note that all of the x_i are assumed to be distinct. The procedure should have the header

```
polyinterp := proc(ldata::list(list),var::name) ...
```

`polyinterp` must return a polynomial in `var`; do not assume, for example, that `var` will always be "x". A sample invocation of `polyinterp` and the resulting output is:

```
> polyinterp([ [0,1], [1,6], [2,4], [3,0] ],'x');

         3       2
  5/6 x   - 6 x   + 61/6 x + 1
```

Prepare the procedure definition (adequately documented and with as much error-checking as possible) in the *Maple* source file (plain-text file) `~/hw2/a5/polyinterp`. I will test your routines with my own input. Note that I wrote (will write) this procedure in class; you are free to copy what I did there verbatim. However, you are encouraged to implement the procedure on your own, working from the basic mathematical description, also covered in class. Finally, my version doesn't exit with an error message if the x_i are not distinct; yours should.