Phy 329: Computational Physics **Homework 2** **Due: Monday, September 16, 3:00pm**

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. You can run* `xmaple` *and* `maple` *on either the SGI machines or the Linux machines. However, in order to complete the problem set, all files required by the assignment must reside in your account on the SGIs. If you prepare and save your worksheets, source files etc. on the Linux machines, be sure to copy them to the correct places in your SGI account using* `rcp` *or* `ftp`*. 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 *Maple* worksheet like the one I went through in class on September 6. (Note that a Postscript version of my worksheet is available on line via the *Class Notes* web page.) You are to work though Chapter 2 *in its entirety*, entering everything which follows a *Maple* prompt (`>`) into your worksheet. Your worksheet should also contain annotations (descriptive text added with the `Insert Text` function of the `Edit` menu) corresponding to the various sections and sub-sections of the Chapter, as mine does. Save the worksheet in the file `~/hw2/a1/the.ms` on your SGI account. Note that `.ms` 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. Note that any plots which are generated by your worksheet will not appear *in* the worksheet: this is normal and you should not be concerned by it.

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

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

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

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

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

Problem 3: Write *Maple* procedures as follows:

- `lreverse := proc(l)` ⋯
  where `l` is of type `list`. `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,l2)` ⋯
  where `l1` and `l2` are both of type `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)` ⋯
  where `lnum` is of type `list(numeric)`. `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')`.

Make sure that *all* three of your procedures do type-checking of their arguments as discussed in class. Also ensure that your procedures are as "bullet-proof" as possible; to test them thoroughly with various input—invalid as well as valid—including null lists (`[]`). All three procedure definitions should be well documented (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 four cases:

- $s_3 = 1/s_1$
- $s_3 = 1/\sqrt{s_1}$
- $s_3 = s_1 s_2$
- $s_3 = s_1/s_2$

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

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,var) ...
```

where `ldata` is of type `list(list)` (list of lists) and `var` is of type `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 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.