I. EXERCISES - SESSION 5

A. Comments on Sessions:

The goals of this session are the following:

1. Using gsl libraries
2. Interpolation
3. Reading from file

Everyone attempts all the problems!

B. Preparations:

Preparations: Download the tar file session05.tar.gz from

www.physics.iitm.ac.in/~suna/nummethods.html

under the section DCF sessions. Untar the file and move into the correct directory.

C. Problems:

1. Interpolation: You have seen in class that the simple Lagrange interpolation that fits a $N-1$ degree polynomial using N points results in the following formula:

$$f(x) = \lambda_0(x)y_0 + \lambda_1(x)y_1 + \cdots + \lambda_{N-1}(x)y_{N-1}$$

where,

$$\lambda_i(x) = \prod_{j=0\, j\neq i}^{N-1} \frac{(x - x_i)}{(x_i - x_j)}$$

where N stands for the number of points you use at a time, x_i and y_i are the points and the function evaluated at the points respectively. Your task is to interpolate the data in the file sample_data.dat using Lagrange interpolation. Note that the original data has energy measured at 25 MeV intervals. Define a new set of points call it x_new such that x_new is at 2 MeV interval. Interpolate the data in the file for the following values of N

(a) $N = 9$, that is taking all the 9 points, which means you interpolate the data with a degree 8 polynomial

(b) $N = 3$, that is taking 3 points at a time, which means you now interpolate with a degree 2 polynomial.

In order to read the data points from the file, use the following piece of code which is one way of reading from a file. (Remember to declare a file pointer called in_ptr at the beginning of the your main code).

```
in_ptr = fopen(``sample_data.dat", ``r"); /*this opens the file in the
read-only mode, therefore the file should exist!*/

fgets(line, sizeof(line), in_ptr);      /*this gets the first line from the
file, which is a comment in this case and hence we do nothing with it*/

n = 0;      /*this is a counter that we use to read from the file and write
into the two arrays x_old and f_old. Use double x_old[N] and double f_old[N] to
declare arrays*/
```

```
while(fgets(line, sizeof(line), in_ptr) != NULL)
{
 sscanf(line,"%lf %lf", &x_old[n], &f_old[n]);

 n ++;
}

N_old = n; /*this is the number of points in the datafile*/
```

The above loop is executed until the end of the file is reached. So in short, we skip the first line since we do nothing with the first line we read using the fgets command, but then use the data from the second line onwards until the file ends. Remember to close the file after you have read the data from it.

Write the value of the function evaluated at the points x_new into a file for both the cases. Plot the data file as well as the two different interpolated functions. The correct curve is a Lorentzian. Which interpolation works well and what do you learn?

2. Using gsl library: Write a code using the gsl library function that obtains the Legendre polynomials as a function of x for x in the range $[-1, 1]$ for $l = 0, 1, 2, 3, 4, 5$. Plot all the polynomials in a single file and be sure to label the axis. You can consult the on-line reference manual for the gsl library function at

   http://www.gnu.org/software/gsl/manual/html_node/Legendre-Polynomials.html

   as well as the examples at the gsl website:

   http://www.gnu.org/software/gsl/manual/html_node/Special-Functions.html

   Be sure to use the header file gsl_sf.h and the extra compilation flags -lgsl -lgslcblas.