

## I. Quadrature by computer

The program **integ.exe** performs numerical integration of  $y(x)$  for a given set of data  $(x, y)$ . Before running the program, prepare a file\* named **integ.txt** with the data: one line per point,  $x$  then  $y$ . They can be separated either by a comma or by spaces (or by both). The points may be unevenly spaced in  $x$ , but they must be in ascending order with respect to  $x$ . A minimum of three points is needed.

Put the file **integ.txt** in the windows folder that contains the file **integ.exe**. Click on **integ.exe** to start the program. You will be asked for the limits of integration. The first limit must be lower than the second. The limits need not be within the range of the data, but if they are not, keep in mind that extrapolation is risky. You can repeat the integration with different limits within one execution of the program.

The results of the program, on the screen as you proceed, are also written into a file **int-out.txt** that can be opened and printed after the program is done.

The program is written in the venerable computer language **FORTRAN**. It works by fitting three adjacent data points to a parabola, and then evaluating the integral under the parabola. (Many other schemes are possible.) The source code is on the back, in case you are interested.

If you use this program for an assigned problem, print the file **int-out.txt**, cut out the results, and tape them to your paper.

\*Manipulating text files. High-level word-processing programs, like **MS Word**, can be used to prepare text files (like **integ.txt**), but you must save them carefully in the correct format. If you save a file as a word document (**integ.doc**), it contains extra information that prevents it from being read properly. Moreover the program **integ.exe** looks specifically for a file called **integ.txt**. **Notepad** is a simple editing program that automatically saves in text format, with no extra information. You can find it under **Start>Programs>Accessories>Notepad**.

## II. Other methods of numerical integration

A) Counting boxes. Plot the function on high quality graph paper (millimeter ruled), using as large a scale as practical. Count the boxes under the curve, carefully estimating fractions. Use the scale on the axes to convert boxes to area.

B) Weighing. Plot the function on high quality graph paper, using as large a scale as practical. Do not write in the area under the curve! Carefully cut out the integral, and also cut out a good-sized blank rectangle from the same piece of paper. Weigh both on an analytical balance. Using the axis scales for your graph, calculate the area of the rectangle in appropriate units. The integral is found from the ratio of weights.