GG 5500 Numerical Methods in the Geosciences
Computer Assignment #5:
Numerical Integration/Using Functions

Assigned: February 10, 2005
Due: February 17, 2005

Relevant reading: Lindfield and Penny, Chapter 4.

The vertical velocity of fluids moving upward in a pipe can be described as function of the pressure gradient (ΔP/L), fluid viscosity (μ), and radius of the pipe (r and R). (R is the total radius).

\[ V_z = \frac{ΔPR^2}{4μL} \left[ 1 - \left( \frac{r}{R} \right)^2 \right] \]

The average velocity in the pipe can be determined by integrating the value of \( V_z \).

\[ \bar{V}_z = \frac{\int_0^{2π} \int_0^R V_z r \, dr \, dθ}{\int_0^{2π} \int_0^R r \, dr \, dθ} = \frac{ΔPR^2}{8μL} \]

This lesson will also introduce the general use of functions and illustrate how the amount of computer resources required to solve various problems can be determined.

1. Use the function simp2 or simp1 (given on p. 167 of Lindfield and Penny) to evaluate the integral shown above for the average velocity of basalt moving up a volcanic pipe with a radius of 10 m. Assume the following parameters: pressure gradient, ΔP/L, is 100 kg m\(^2\)s\(^{-2}\) and fluid viscosity, μ, is 10\(^3\) Pa S (kgm\(^{-1}\)s\(^{-1}\)). Find the appropriate number of Simpson rule intervals so that this method is within 10\(^{-6}\) of the value given by the exact solution of the integral (ΔPR\(^2\)/8μL).

2. Use the function Gauss_quad (which will be e-mailed to all of you) to calculate the value of the integral using a variety of quadrature points. As with problem 1, determine the number of quadrature points so that this method is within 10\(^{-6}\) of the value given by the exact solution.