Mathematics 373
Numerical Analysis I
PROGRAMMING ASSIGNMENT 2

Due Thursday, April 27, 2000

This assignment is solving ODE initial value problems. Write the following as procedures, using any language in which you can not only turn in the programs, but also give me printout of their usage. If the language you choose does not have the ability to input functions from the terminal, write the programs as subroutines and a calling program which enables different functions it contains to be used by single subroutines. You need not do fancy I/O. You may pass parameters, including functions, to these routines either as parameters in calls to them or by any other mechanism which enables the same routine to operate on different functions, but the functions SHOULD NOT be incorporated as a basic part of the routine that does the computations—you should not have to copy an object containing the function over and modify a portion of it to rerun the same routine.

The procedures, including the IVPs to which you should apply them:

1. Runge-Kutta-Verner adaptive method on page 292: 4. This uses an order 5 and an order 6 method to do variable step size. If the step size is acceptable, use the order 6 approximation for your w_i.

   (a) $y' = \frac{y}{t} - \left(\frac{y}{t}\right)^2\,, \quad 1 \le t \le 3\,, \quad y(1) = 1\,, \quad hmax = 0.5\,, \quad hmin = 0.05.$

   (b) $y' = -(y+1)(y+3)\,, \quad 0 \le t \le 2\,, \quad y(0) = -2\,, \quad hmax = 0.5\,, \quad hmin = 0.05.$

2. Adams Fourth-Order Predictor-Corrector page 302.

   (a) $y' = \frac{y}{t} - \left(\frac{y}{t}\right)^2\,, \quad 1 \le t \le 3\,, \quad y(1) = 1\,.$

   (b) $y' = -(y+1)(y+3)\,, \quad 0 \le t \le 2\,, \quad y(0) = -2\,.$

3. Runge-Kutta Method for Systems of Differential Equations p 320.

   (a) $y'' - 2y' + y = te^t - t\,, \quad 0 \le t \le 1\,, \quad y(0) = 1\,, \quad y'(0) = 2.$ Use $h = .01$.

   (b) $u_1' = 3u_1 + 2u_2 - (2t^2+1)e^{2t} \qquad u_2' = 4u_1 + u_2 + (t^2 + 2t - 4)e^{2t}$
   $u_1(0) = 1\,, \quad u_2(0) = -1\,, \qquad h = 0.1$