Numerical Methods – Spring '18

PA #7

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Programming Assignment #7

Problem 1:

Write a MATLAB function file that implements *Heun's* method for numerically solving a first order ODE over a given interval with a specified initial condition, a specified step size, and a specified local error tolerance. A first order differential equation is of the form $\frac{dy}{dx} = f(x, y)$. Your function should accept a row vector $[x_0\ x_n]$ that represents the range of x-values to produce a solution over. You should include an initial value y_0 (so, $y(x_0) = y_0$), the step size h, and finally the error tolerance that tells Heun's method to stop iterating. Your function should return two row vectors, one containing the x-values and the other containing the y values.

My Solution:

See leurodriguez1.m

Problem 2:

When a rocket launches, it burns fuel at a constant rate of m_F (kg/s) as it accelerates, maintaining a constant thrust of T. The weight of the rocket, including fuel is 1200 kg (including 900 kg of fuel). So, the mass of the rocket changes as it accelerates:

$$m(t) = 1200 - m_F t$$

We'll assume that the rocket experiences a drag force proportional to the square of velocity. Using *Newton's* Second Law of Motion, we can write down the equation of the height of the rocket *y(t)* as a function of time, *t.* Namely,

$$m(t)\frac{d^2y}{dt^2} = T - m(t)g - c_d\left(\frac{dy}{dt}\right)^2$$

We'll assume an initial height of $y(0) = 0$ and an initial velocity of $\frac{dy}{dt}(0) = 0$. Here $g = 9.81$ is the acceleration due to gravity. Write a function that inputs a value for the thrust T, a value for the drag coefficient c_d, a value for the burn rate m_F, a 2-element row vector specifying the range of values to solve the IVP over, and a value for the step size h. Your function should implement the fourth order Runge Kutta method to return a row vector of the t-values and a row vector of the corresponding y values as computed by Runge Kutta.

My Solution:

See leurodriguez2.m