Assignment 17

Second order Runge-Kutta method of solving second order differential equation

Q1 1D free fall motion with drag force

- A freely falling object through a fluid medium can alternatively be modeled such that the drag force is proportional to its speed. The second order differential equation for the instantaneous position $y(t)$ for such an object is given by

$$\frac{dv}{dt} = -g - \frac{k}{m}v \Rightarrow \quad \frac{d^2y}{dt^2} = -g - \frac{k}{m}\frac{dy}{dt}$$

- Let *k*=0.01, *m*=1;*g*=9.81 $\mathrm{m/s^2}$; and the boundary condition be $v(0) = 0\ \mathrm{m/s}, y(0) = 0.$
- Use **NDSolve**[ ] to obtain and plot the numerical solution for $y(t)$ until it enters a terminal velocity.
- Develop a DIY code implementing RK2 method to numerically solve the equation.
- Overlap your RK2 numerical solution on top of that obtained from **NDSolve**[ ]. Both should agree to each other.

Q2:

Develop a code to implement RK2 for the case of a pendulum experiencing a drag force, with damping coefficient q= 0.1* (4Ω), Ω= $\sqrt{g/l}, l = 1.0$ m. Boundary conditions: $\theta(0) = 0.2; \omega(t = 0) = 0;$

$$\frac{d^2\theta}{dt^2} = -\frac{g}{l}\theta - q\frac{d\theta}{dt}$$