ZCE 111
Assignment 11

Q1: Free fall with drag force

A freely falling object through a fluid medium can alternatively be modeled such that the drag force is proportional to the square of its speed. The first order differential equation for such an object is given by

$$\frac{dv}{dt} = -g + kv^2$$

Let k=0.01, and the boundary condition is $v(0)$ = -20 m/s.

Use DSolve to obtain the analytical solution for $v(t)$.

Develop a code that implements Euler's method to numerically solve the equation for tfinal=20.0s.

Overlap your numerical solution on top of the analytically obtained plot. Both should agree to each other.

Q2: Free fall with drag force

Solve the vertical position of the falling object in Q1 numerically as a function of time *t* in the previous exercise using Euler's method. You must make use of the analytical expression of *v*(*t*) as obtained from your solution for that exercise. Assume the initial condition *y*(0)=0.

$$\frac{dy(t)}{dt} = v(t)$$

What is the value of *y*(tfinal)?

Q3: Forced pendulum

Use DSolve to solve the forced oscillator. Plot on the same graph the analytical solutions of $\theta(t)$ for t from 0 to 10 T , where $T = 2\pi/\Omega$, $\Omega = \sqrt{g/l}$, for $\Omega_D = 0.01\Omega, 0.5\Omega, 1.0\Omega, 1.5\Omega, 4\Omega$.

Assume the boundary conditions $\theta(t=0)=0$; $d\theta/dt(t=0)=0$; $m=l=F_D=1$; $q=0$.

$$\frac{d^2\theta}{dt^2} = -\frac{g}{l}\theta - q\frac{d\theta}{dt} + \frac{F_D \sin(\Omega_D t)}{ml}$$

Q4: Forced pendulum, again

Use DSolve to solve the forced oscillator. Plot on the same graph the analytical solutions of $\theta(t)$ for t from 0 to 10 T , where $T = 2\pi/\Omega$, $\Omega = \sqrt{g/l}$, for $\Omega_D = 1.0\Omega$, q=0.01, 0.1, 1.0. Assume the boundary conditions $\theta(t=0)=0$; $d\theta/dt(t=0)=0$; $m=l=F_D=1$;

Q5: Forced pendulum, using **NDSolve**

Repeat Q4, but use **NDSolve** (instead of **DSolve**).