Homework 3 (PHYS-5319, Math-3), Due Thursday, July 14.

1. The velocity (v) of an electric bicycle with the power output (P) of the motor is described by the following differential equation:

$$\frac{dv}{dt} = \frac{P}{mv}$$

where m is the total mass (bicycle + rider). Given $v(0)$=4.0 m/s, P=400 Watt, m=70 kg, and Δt (or h) 0.1 sec., solve the $v(t)$ by 2nd-order Runge-Kutta method for time interval [0, 200]. compare the result with the exact solution $v = \sqrt{v(0)^2 + 2Pt/m}$.

(plot v against t)

(you may vary time step to see the accuracy variation)

2. Add in a air-grad term, $-Av^2$, on the right-hand of the equation in Problem 1, where A is proportional to the frontal area and the air density. Then solve for $v(t)$ using A= 0.15 and compared the result to the solution with A=0.

3. Use 4th-order Runge-Kutta to solve a damped oscillation problem for t=[0,10] sec.:

$$\frac{d^2x}{dt^2} = -\omega^2 x - \alpha \frac{dx}{dt}$$

where ω=3.0, x(0)=1.0, dx/dt(0)=0, and α=0.5.
Plot x vs t.

You may copy and modify the code:

/home/z/zh/zhang/phys5319/Oscillate_rk2.f