<u>Assignment-2</u> deadline: 27th January, 2015

Assignments must be submitted in the form of report along with MATLAB codes. For all the problems below, provide graphs in your report. Instruction regarding submission of report will be provided by the Lab instructors.

1. Write down the equation for position of an object moving horizontally with a constant velocity "v".
   Assume v=50 m/s, use the Euler method (finite difference) to solve the equation as a function of time.
   - Compare your <u>computational result</u> with the exact solution.
   - Compare the result for different values of the <u>time-step</u>.

2. Parachute problem: frictional force on the object increases as the objects moves faster (as we learned today in the class). Role of parachute is to produce the frictional force in the form of air drag. Consider the most simple form, so the equation for velocity :

   $$\mathbf{dv/dt = a - bv}$$

   where a (from applied force), b (from friction) are constants.
   Use Euler's method to solve for "v" as a function of time. Choose a=10 and b=1.
   What is the terminal velocity in this case.

3. Population growth problem can be modeled using a rate equation :

   $$\mathbf{dN/dt=aN-bN^2}$$

   N→ number of individuals which varies with time.

   First term (aN)→ birth of new members

   Second term (bN^2)→ corresponds to death; proportional to N^2 because food will become harder to find when population becomes very large.

   Use the Euler method to solve the equation as discussed in the class for the decay problem. Take a=10 and b=0; then take a=10, b=3.

   Compare your numerical solution with exact solutions.

For different values of "a" and "b", give some explanations regarding your result.

4. Bicycle problem:

(a) Rewrite the bicycle problem/code as discussed in the class. Investigate the effect of rider's power, mass and frontal area on the ultimate velocity.

Generally for a rider in the middle of a group the effective frontal area is about 30% less than the rider at the front. How much less energy does a rider in the group expend than one at the front (assuming both moving at 12.5 m/s).

(b) Run your code (<u>case (a)</u> discussed during class) with initial v=0; observe the output and give possible explanation. Explain why it is important to give a non-zero initial velocity.

(c) As discussed in the class, we have assumed that the bicyclist maintains a constant power. What about the assumption when the bicycle has a very small velocity? (instantaneous power=product of force and velocity).

(d) At low velocities it is more realistic to assume, that the rider is able to exert a constant force. That means for small "v" there is a constant force, which means eqn is dv/dt=F0/m

Modify your matlab code to include this term for small velocities, that means we have 2 regimes and 2 eqns one for small velocities and one for larger velocities. Make your code work automatically for both the regimes and crossover from small to large v occur when the power reaches $P(=F_0v)$. Take $F_0=P/v$ where v=5m/s.

Change different parameters and report about important observations.