LabVIEW Simulation Exercises

Requirements: LabVIEW + LabVIEW Control Design and Simulation Module.

Exercise 1: Bacteria Population

In this example we will use LabVIEW and the LabVIEW Control Design and Simulation Module to simulate a simple model of a bacteria population in a jar.

The **model** is as follows:

$$birth\ rate = bx$$

$$death\ rate = px^2$$

Then the total rate of change of bacteria population is:

$$\dot{x} = bx - px^2$$

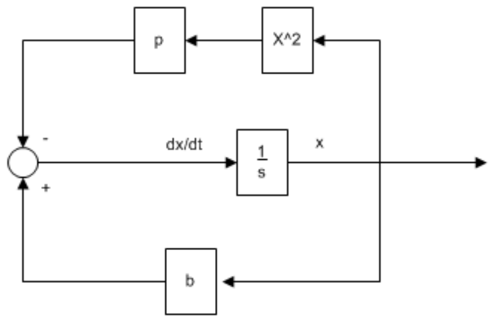
Set ***b=1***/hour and ***p=0.5*** bacteria-hour

We will simulate the number of bacteria in the jar after **1 hour**, assuming that initially there are **100 bacteria** present.

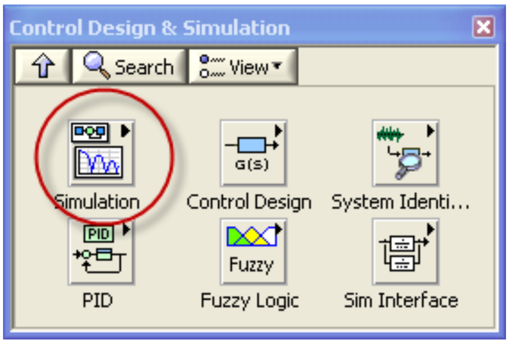
Procedure:

1. Draw Block Diagram using pen and paper
2. Start LabVIEW and use the **Control and Simulation Loop** from Control Design and Simulation Palette in LabVIEW
3. Drag in the necessary Blocks from the palette.
4. Use the "**Connection Wire**" from the **Tools palette** and draw the necessary wires.
5. **Configure Simulation Parameters** (right-click on the Control and Simulation Loop border)
6. Start the Simulation

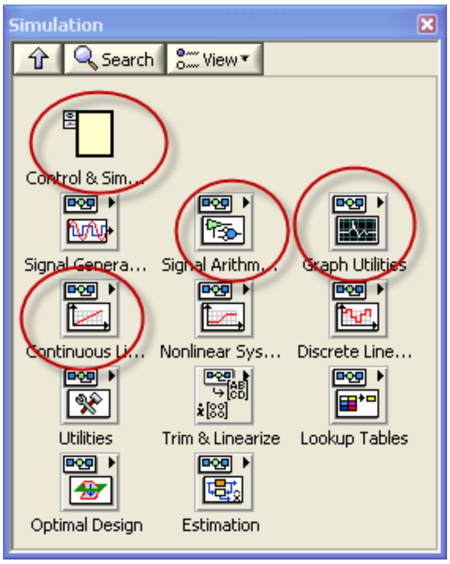
Block Diagram:



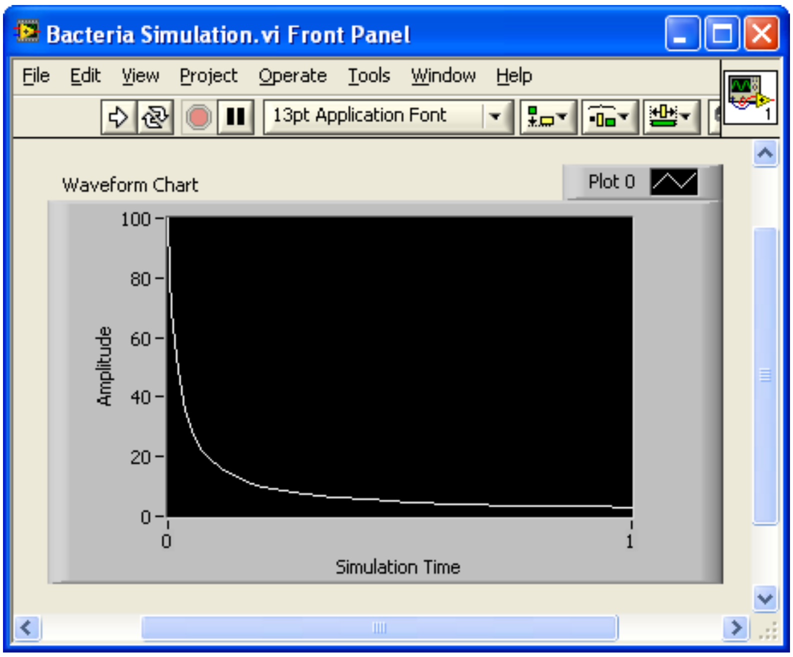
Control Design and Simulation Palette in LabVIEW:



Simulation Palette in LabVIEW:



Simulation Result:



Exercise 2: Mass-Spring-Damper System

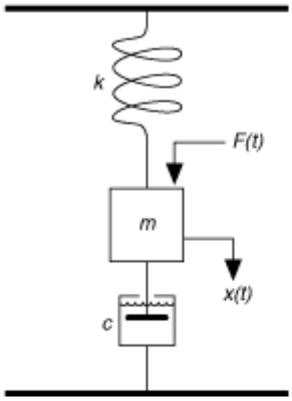
In this example we will create a mass-spring-damper model in LabVIEW and configure and run the simulation in LabVIEW.

In this exercise you will construct a simulation diagram that represents the behavior of a dynamic system. You will simulate a spring-mass damper system.

$$F(t) - d\dot{x}(t) - kx(t) = m\ddot{x}(t)$$

where t is the simulation time, F(t) is an external force applied to the system, d is the damping constant of the spring, k is the stiffness of the spring, m is a mass, and x(t) is the position of the mass. $\dot{x}$ is the first derivative of the position, which equals the velocity of the mass. $\ddot{x}$ is the second derivative of the position, which equals the acceleration of the mass.

The following figure shows this dynamic system.



The goal is to view the position x(t) of the mass m with respect to time t. You can calculate the position by integrating the velocity of the mass. You can calculate the velocity by integrating the acceleration of the mass. If you know the force and mass, you can calculate this acceleration by using Newton's Second Law of Motion, given by the following equation:

Force = Mass × Acceleration

Therefore,

Acceleration = Force / Mass

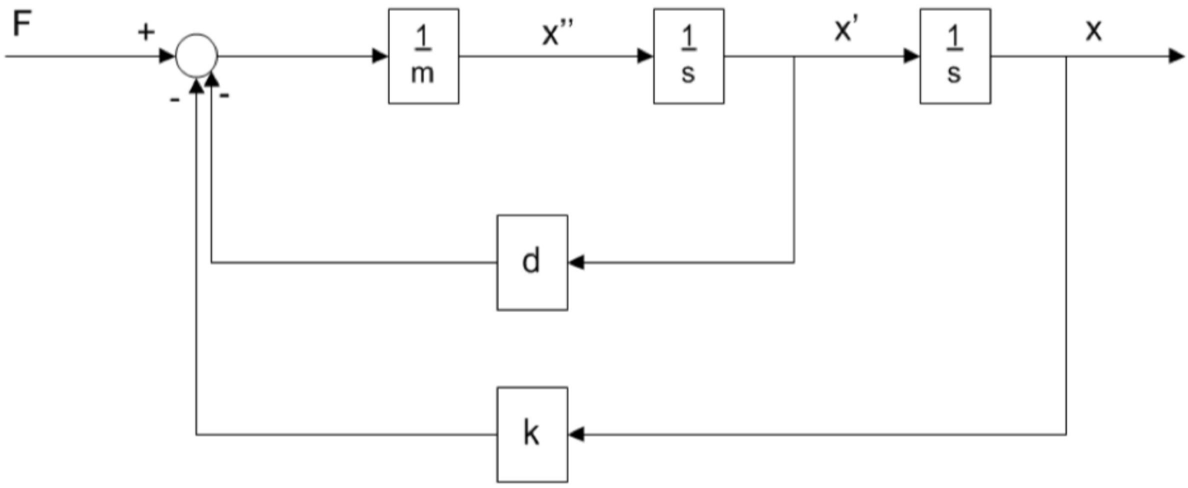
Substituting terms from the differential equation above yields the following equation:

$$\ddot{x} = \frac{1}{m}(F - d\dot{x} - kx)$$

You should create the block diagram for the mass-spring-damper model above in LabVIEW and Simulate it (make a plot).

Try out different values for the parameters (m, k, d, etc.) that are used the simulation.

Below you see a Block Diagram of the system (which you should implement using the blocks available in LabVIEW):


F
+
-
-
1
m
x''
1
s
x'
1
s
x
d
k