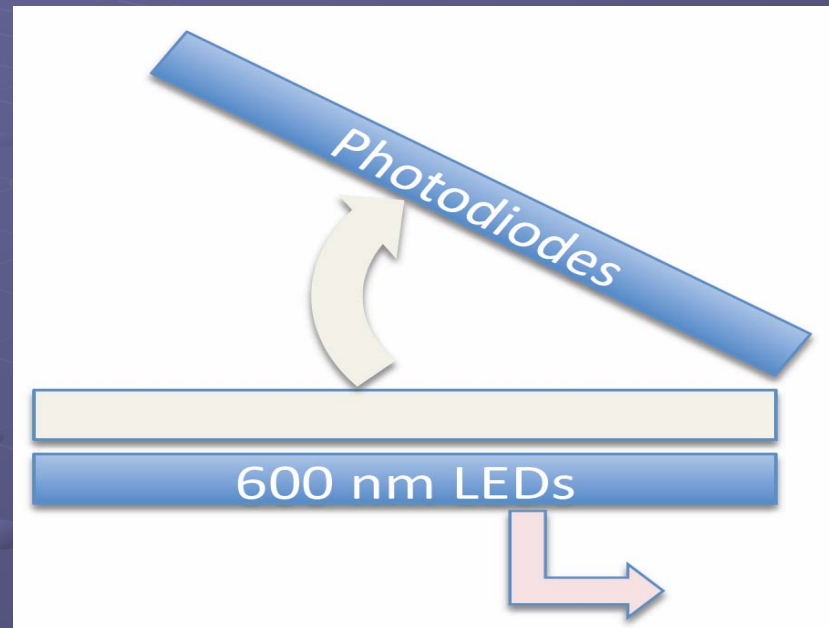


Turbidostat System Model



By

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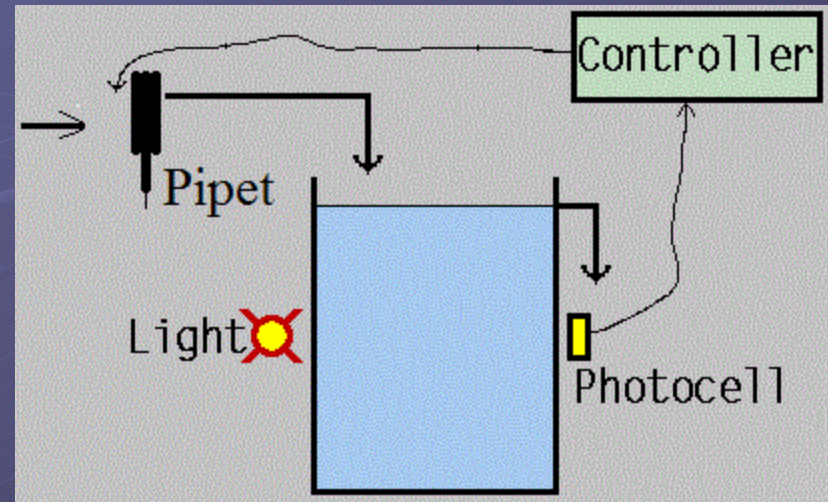
Project Overview

● Functionality of Turbidostat

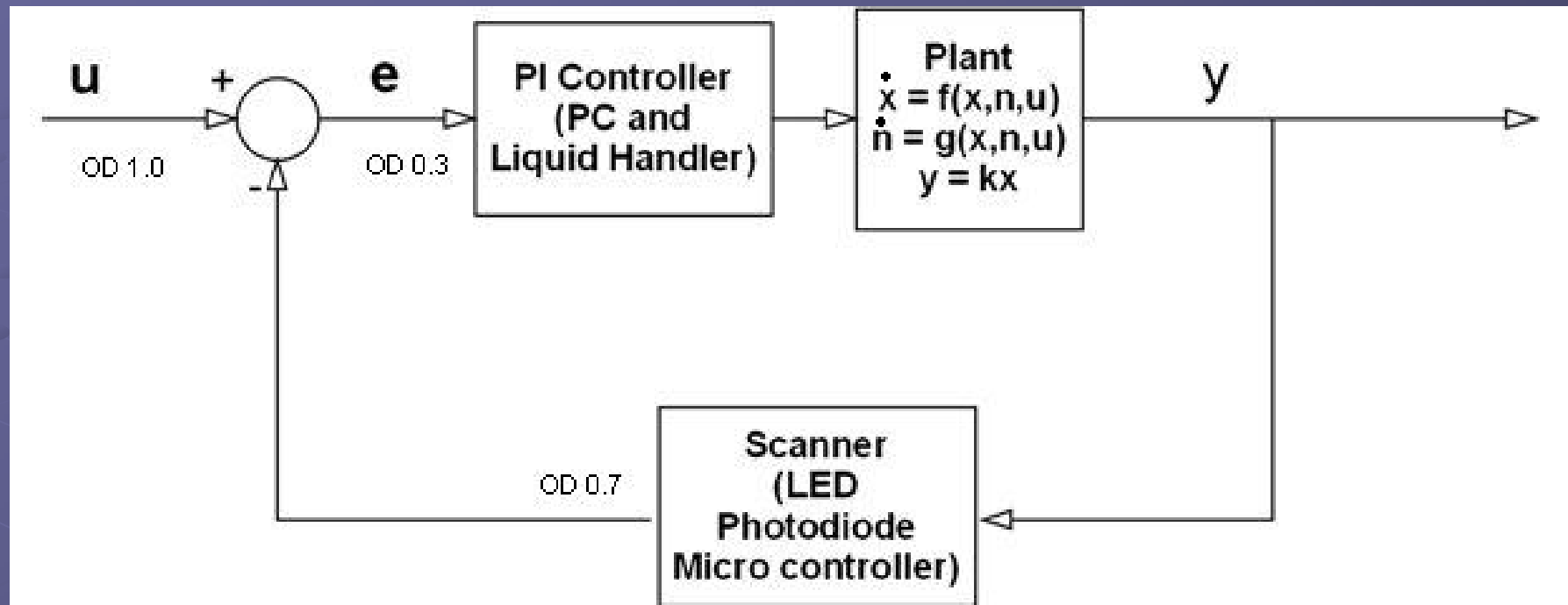
- Measure light absorbed by bacteria
- Provide feedback to controller to add correct amount of nutrients
- Keep bacteria population at a constant optical density

● Functionality of Liquid Handler

- Implement PI controller
- Pipet media into plate wells



Block Diagram



- X is the population of bacteria (g/L)
- N is amount of nutrients (g/L)
- U is the reference point
- Output from scanner is measured in optical density (OD) which is: $OD_{600} = \text{Log}_{10}(I_0 / I)$

System Equations

$$\begin{aligned}\bullet \quad \dot{x} &= \frac{vnx}{k+n} - ux \\ \bullet \quad \dot{n} &= -\gamma \frac{vnx}{k+n} + u(n_0 - n) \\ y &= kx\end{aligned}$$

For our simulation:

$v = 2$ generations per hour

$k = 1$

$\gamma = 0.5$

$n_0 = 1$

$x_0 = 0.5$

PARAMETERS

v = maximum growth rate
(generations/hour)

k = half saturation constant (g/L)

γ = nutrient mass used per bacteria
mass grown (unitless because it's a
ratio)

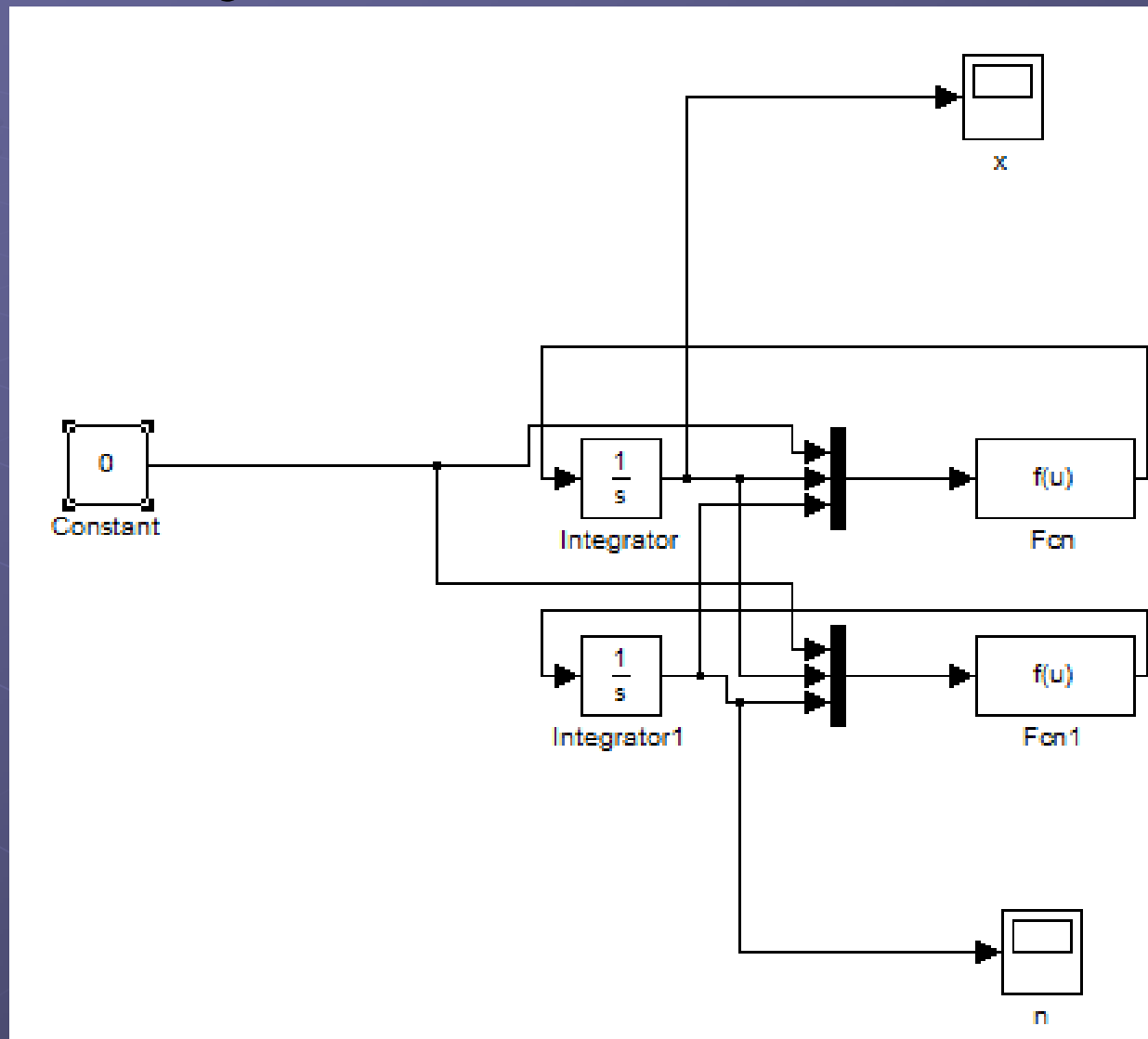
n_0 = nutrient concentration in fresh
media (g/L)

STATES

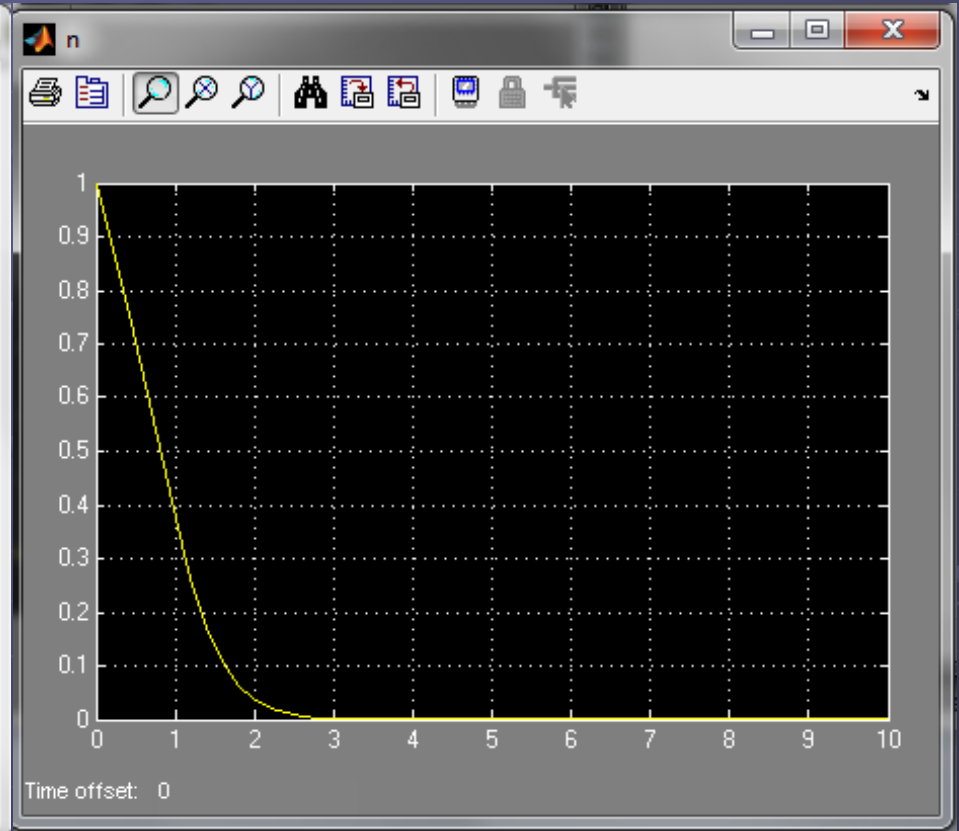
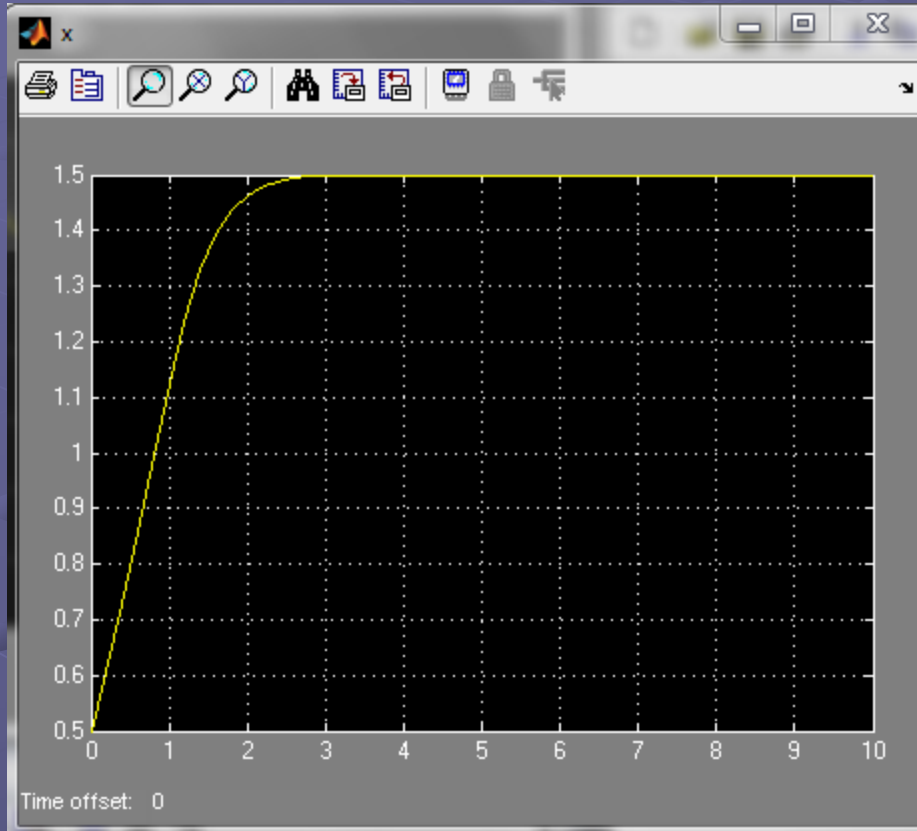
x = amount of bacteria (g/L)

n = amount of nutrients (g/L)

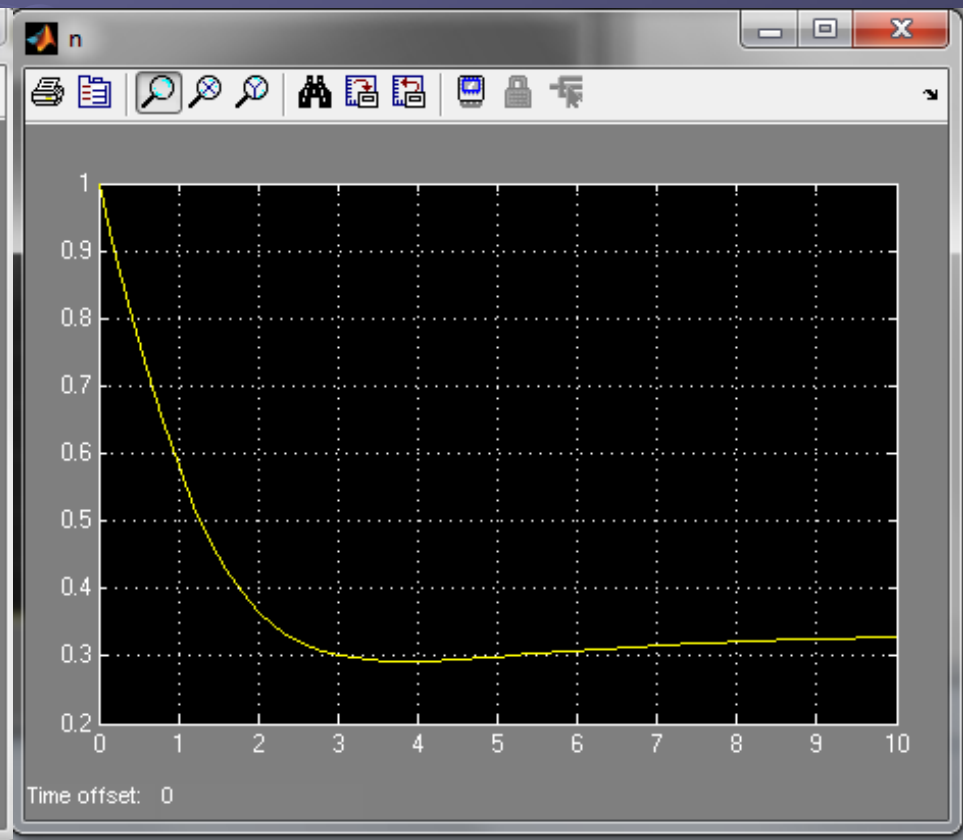
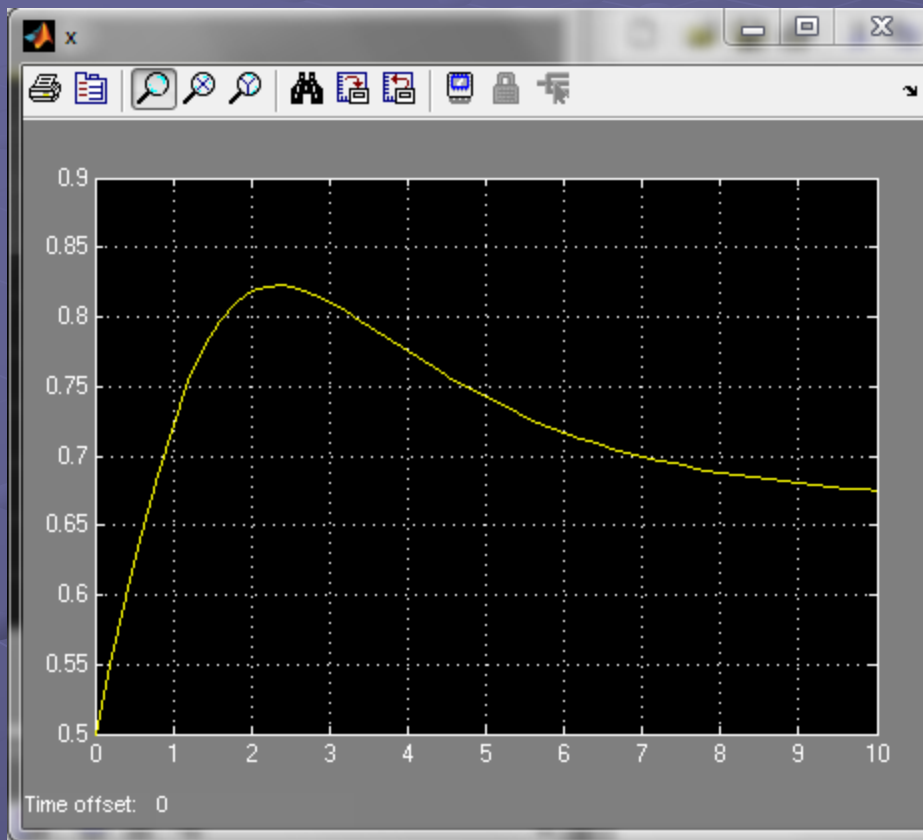
System Simulation



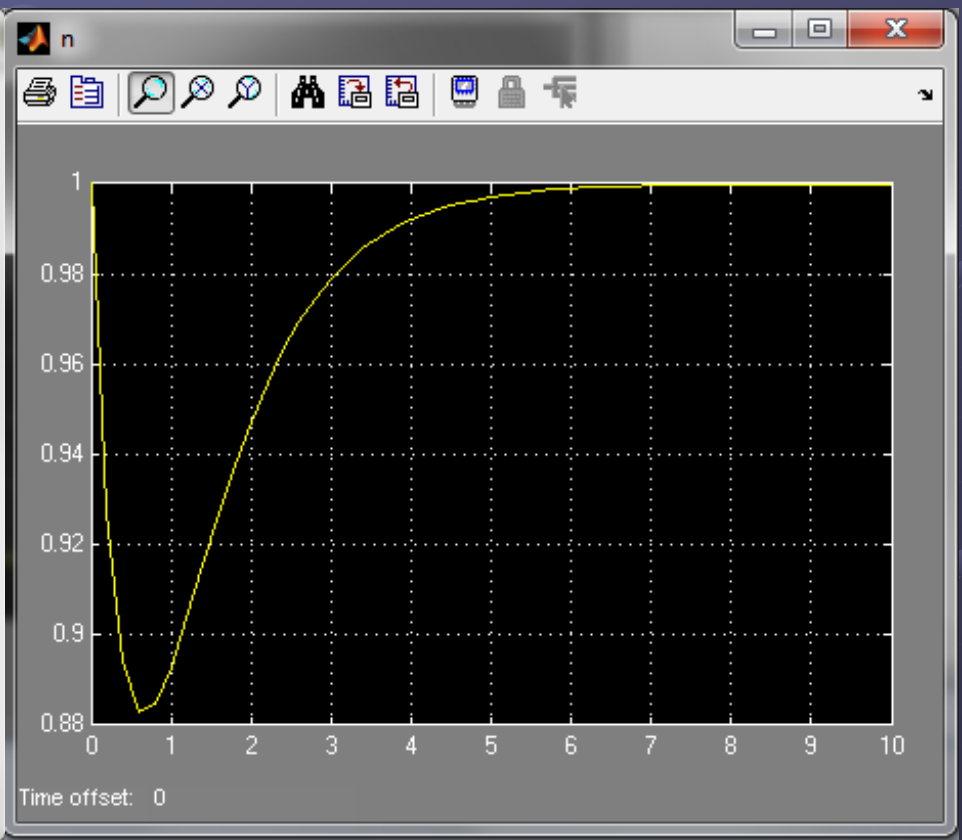
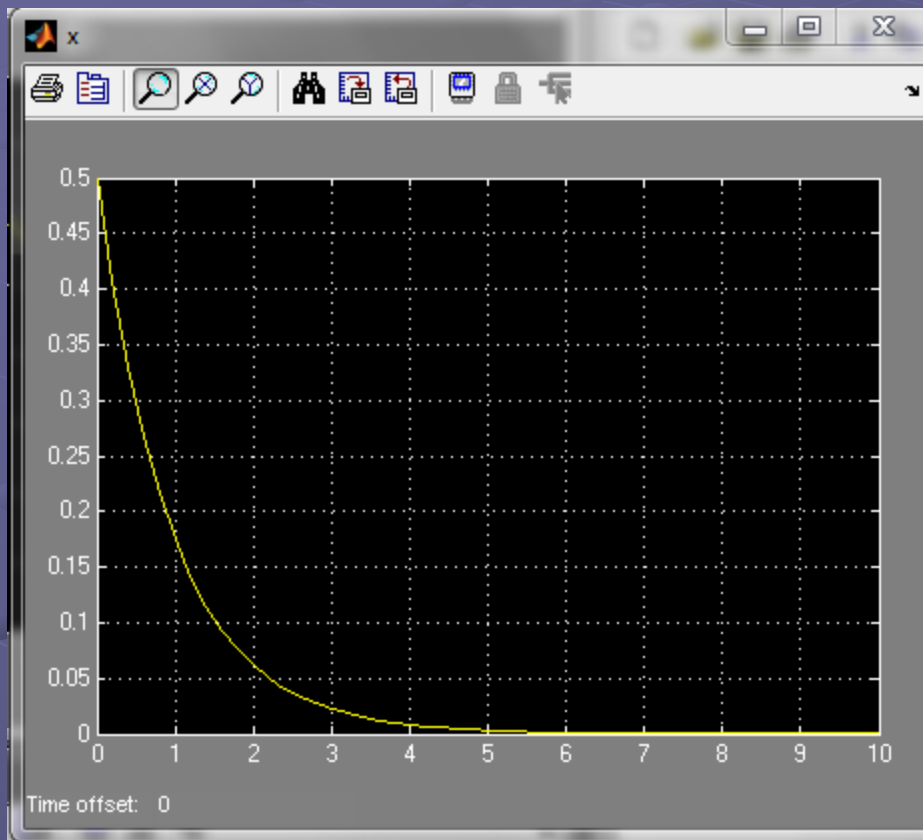
System Simulation (cont...)



System Simulation (cont...)



System Simulation (cont...)



Controllable or Observable System?

- Controllable

- System states can be changed by changing the inputs

- Not Controllable

- Cannot produce negative bacteria

- Observable

- Able to observe through output measurements the initial states of a system.
- Parameter v

Model Specifics

- Our model seems to be running as one would expect
- Will need to test our actual system with the given parameters to see how it actually compares to our models
- Needs to be pretty accurate in order to maintain the population levels that are desired

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