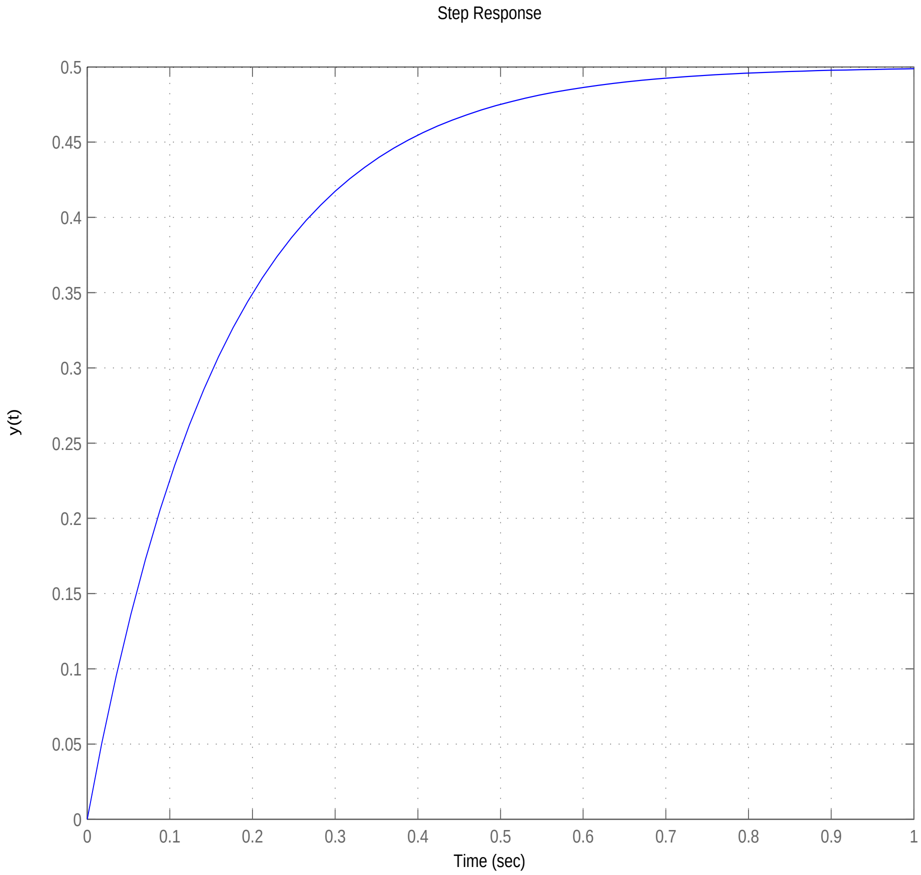
ELE 457 **Homework #2** **Fall 2009**

Due Tuesday, October 6

1. The plot below shows the response, $y(t)$, of a first-order system, $b/(s+a)$, to a step input of height 3.



The purpose of this problem is to find the values of a and b from the step-response plot. Note that the equation for $y(t)$ is

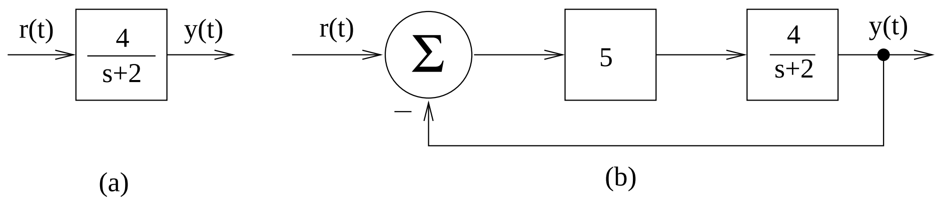
$$y(t) = \frac{3b}{a}(1 - e^{-at}).$$

The steady-state value of $y(t)$, call is y_{ss}, can be obtained from the graph and is given by the expression

$$y_{ss} = \frac{3b}{a}.$$

Note that at time $t = 1/a$ seconds, the expression $1 - e^{-at}$ equals $1 - e^{-1}$, which equals 0.63. Thus, the time at which the response, $y(t)$ crosses the value of $0.63y_{ss}$ is equal to $1/a$. This allows the value of a to be determined from the plot.

2. Sketch (by hand) the unit step responses of the following systems. Label the steady-state values and the settling times on the graphs.

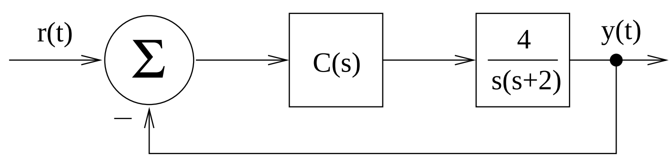


3. Problem 4.2 from the book.

4. Problem 4.4 (a) from the book. Find ζ and ω_n for the closed-loop system. Sketch (by hand) the unit step response.

5. Problem 4.14(a) from the book.

6. Consider the following control system:



(a) Let $C(s) = K$. Find the value of K that results in the closed-loop system having a damping ratio of $\zeta = 1.2$. What are the closed-loop poles? What is the approximate settling time?

(b) Now let $C(s) = K(s + \beta)/(s + \alpha)$. Find the values of K, β, α so that the closed-loop system again has a damping ratio of $\zeta = 1.2$ but has a settling time that is half of that found in part (a).