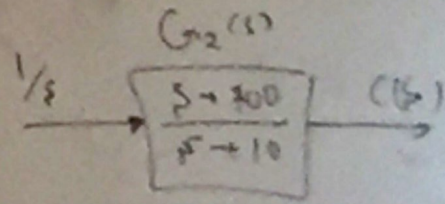
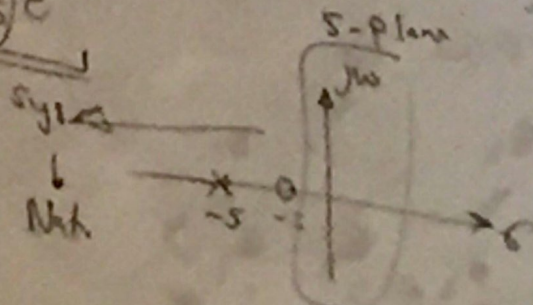
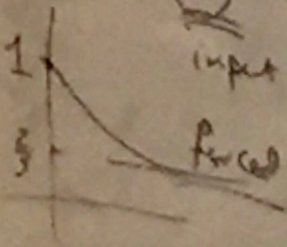
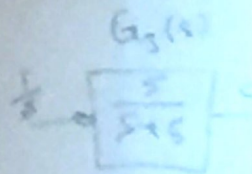
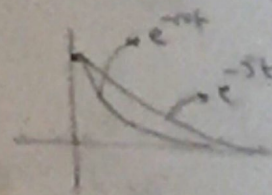


$$C(s) = \frac{s+2}{s(s+5)} = \frac{2/5}{s} + \frac{3/5}{s+5}$$

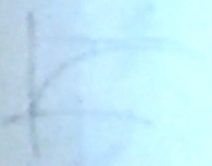
$$C(t) = \frac{2}{5} + \frac{3}{5} e^{-5t}$$

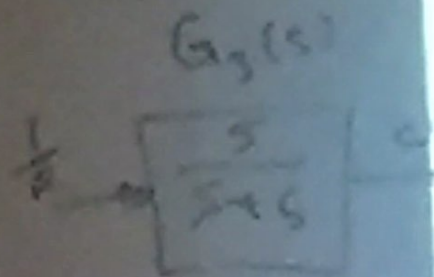
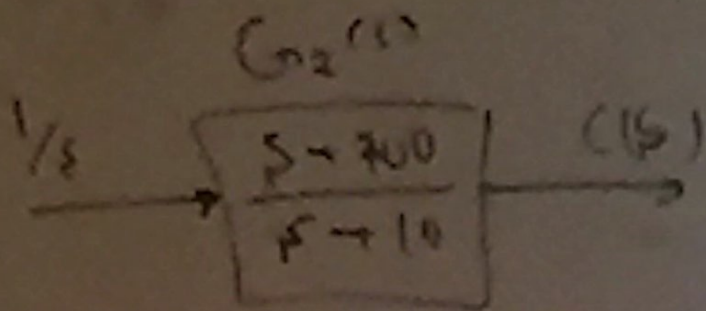


$$C(t) = \frac{2}{5} + \frac{3}{5} e^{-10t}$$



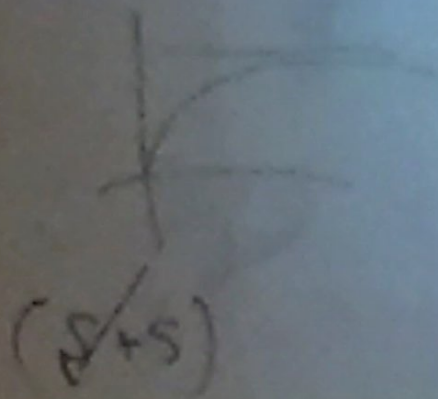
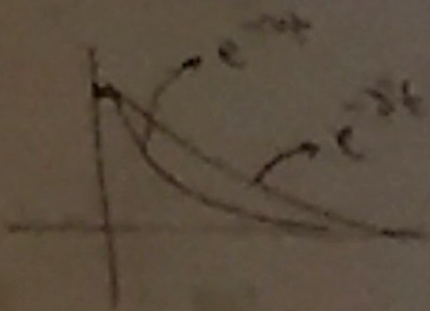
$$C(t) = 1 - \frac{5}{5} e^{-5t}$$



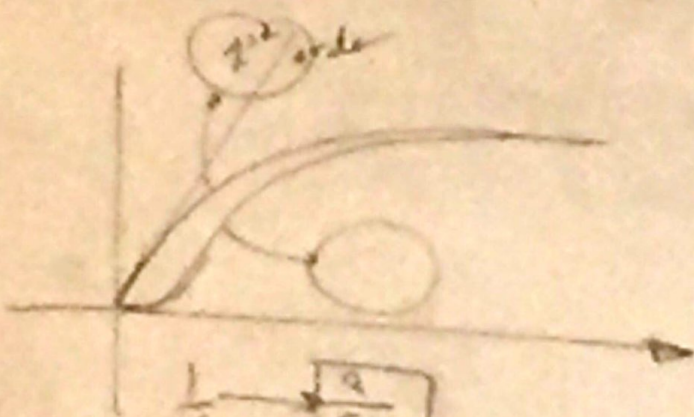


$$C(t) = \left(\frac{2}{10} \right) + \left(\frac{8}{10} \right) e^{-10t}$$

$$C(s) = (1) - \frac{5}{s+5}$$

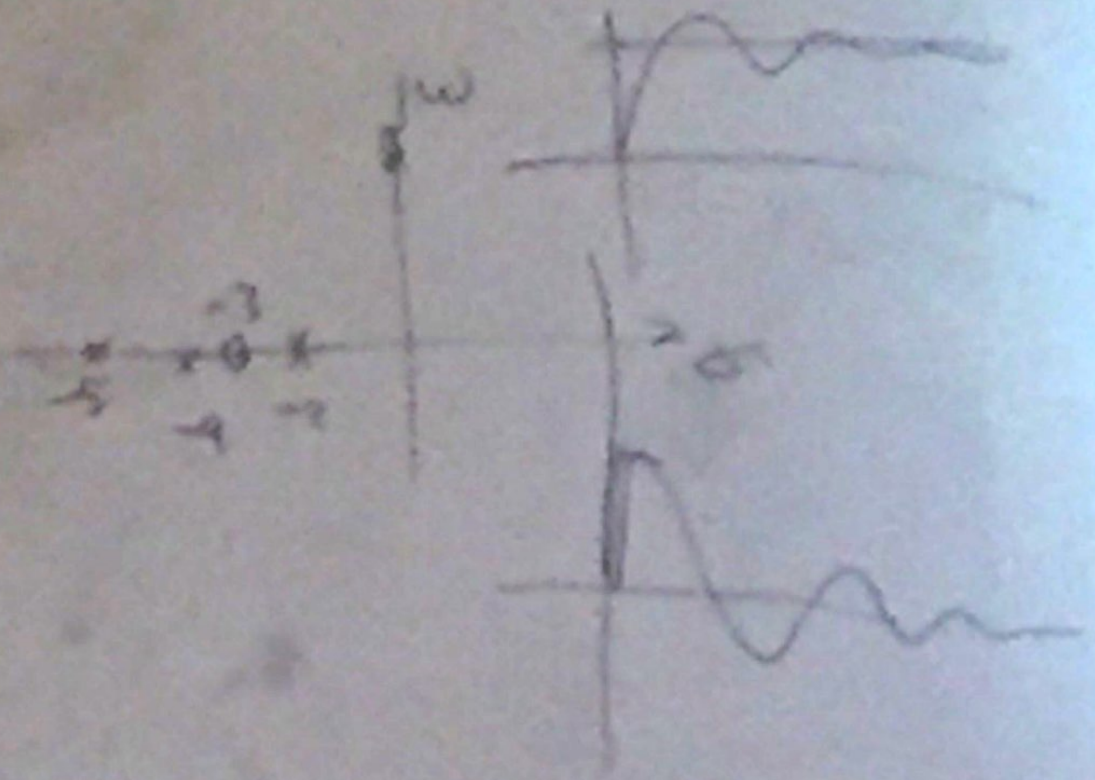


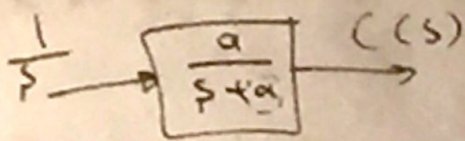
$$(s+1) \left(\frac{s}{s+5} \right) (s+10)$$



$$\left. \frac{d}{dt} C(t) \right|_{t=0} = a e^{-at} \Big|_{t=0} = a$$

$$f(t) = k_1 + k_2 e^{-2t} + k_3 e^{-4t} + k_4 e^{-5t}$$





$$T_r = t \Big|_{C(t)=0.9} - t \Big|_{C(t)=0.1} = \frac{2.3}{a} - \frac{0.11}{a} \approx \frac{2.2}{a}$$

$$\textcircled{1} \quad C(t) = 1 - e^{-at} = 0.9$$

$$e^{-at} = 0.1$$

$$-at = \ln 0.1$$

$$t = \frac{\ln 0.1}{-a} = \frac{2.3}{a}$$

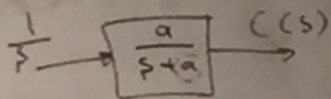
$$0.1 = 1 - e^{-at}$$

$$e^{-at} = 0.9$$

$$t = \frac{\ln 0.9}{-a} = \frac{0.11}{a}$$

$$\frac{d}{dt} C(t) = a e^{-at} \Big|_{t=0} = a$$

$$C\left(\frac{1}{a}\right) = 1 - 0.37 = 0.63$$



T_s 98% final value
 2% of " "
 95%

$$T_s = t \Big|_{c(t)=0.9} - t \Big|_{c(t)=0.1} = \frac{2.3}{a} - \frac{0.1}{a} = \frac{2.2}{a}$$

$c(t) = 1 - e^{-at} = 0.9$
 $e^{-at} = 0.1$
 $-at = \ln 0.1$
 $t = \frac{\ln 0.1}{-a} = \frac{2.3}{a}$

$0.1 = 1 - e^{-at}$
 $e^{-at} = 0.9$
 $t = \frac{\ln 0.9}{-a} = \frac{0.11}{a}$

$T_s =$
 $c(t) = 0.98 = 1 - e^{-at}$
 $e^{-at} = 0.02$
 $t_s = \frac{\ln 0.02}{-a} = \frac{3.9}{a}$

$\frac{d}{dt} c(t) = a e^{-at}$
 $t = 0 \quad t = \infty$
 $c(0) = 1$

4.3 first-order systems

Characteristics

- 2% Settling time, T_s :
- The time for the response to reach, and stay within, 2% (arbitrary) of its final value. The time when $c(t) = 0.98$.

$T_s = \frac{4}{a}$

First-Order Transfer Functions via Testing

- We determine that it has the first-order characteristics we have seen thus far, such as:
 - no overshoot.
 - nonzero initial slope.
- The transfer function for the system is

$$G(s) = 5.54/(s+7.7)$$

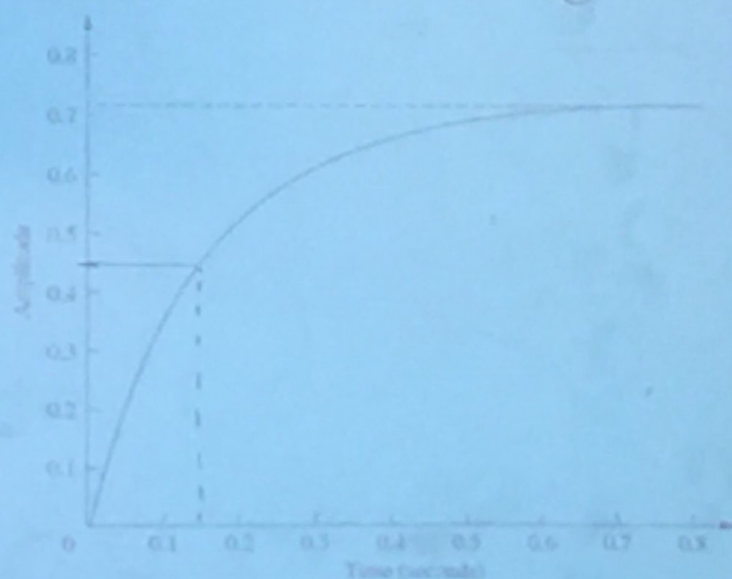


FIGURE: Laboratory results of a system step response test

$$G(s) = \frac{K}{s+a}$$

$$R(s) = \frac{1}{s}$$

$$C(s) = \frac{K}{s(s+a)}$$

$$C(t) = \left(\frac{K}{a}\right) - \frac{K}{a} e^{-at}$$

$$t = \frac{1}{a} \Rightarrow a = \frac{1}{\text{Time Const.}}$$

$$a = \frac{1}{0.13} = 7.7$$

$$\frac{K}{a} = 0.72$$

$$K = 5.84$$

$$T_r = t \Big|_{C(t)=0.9} - t \Big|_{C(t)=0.1} = \frac{2.3}{a}$$

$$C(t) = 1 - e^{-at} = 0.9$$

$$e^{-at} = 0.1$$

$$-at = \ln 0.1$$

$$t = \frac{\ln 0.1}{-a} = \frac{2.3}{a}$$

$$0.1 = 1 - e^{-at}$$

$$e^{-at} = 0.9$$

$$t = \frac{\ln 0.9}{-a} = \frac{0.11}{a}$$

$$T_s =$$

$$C(t) = 0.98 = 1 - e^{-at}$$
$$e^{-at} = 0.02$$