Automatic Control – EEE 2002 Tutorial Exercise III

A first order system is given by $G(s) = \dfrac{k}{s+a}$.

1. Write the transfer function as: $G(s) = \dfrac{k'}{\tau s + 1}$ and hence find the value of the DC gain (k') and of the system's time constant (τ).

$$G(s) = \frac{k}{s+a} = \frac{k/a}{\frac{1}{a}s + 1}, \text{ so } k' = k/a \text{ and } \tau = 1/a.$$

2. For $k=1$ and $a=5$ repeat the previous step.

$$G(s) = \frac{0.2}{0.2s + 1}$$

3. Based on the previous answer predict the behaviour of the system for a (unit) step input.

   The system will exponentially converge to 0.2 (the dc gain) and it is going to reach the value of 0.6321*0.2=0.1264 at 0.2s (the time constant).

4. Find the step response of that system using Matlab **<u>AND</u>** Simulink and hence crosscheck your previous answer:

   ```
   num=0.2; den=[0.2 1]; step(num,den)
   ```
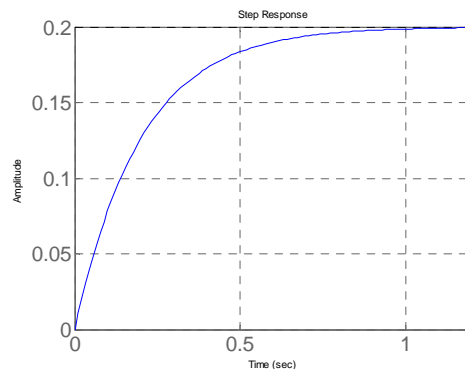

See also sim model

5. Using the appropriate Matlab commands find (exactly) the steady state value and the time constant of the system and hence further crosscheck your previous results.
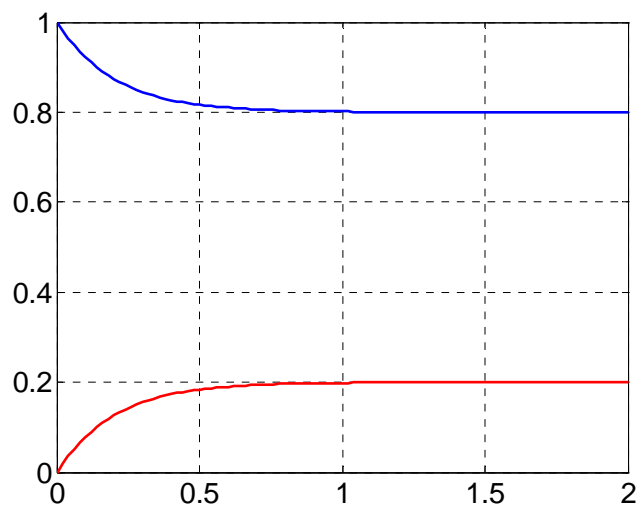
```
[y,t]=step(tf(num,den),2);
y(end)
k=find(y>0.6123*y(end));
t(k(1))

ans =

     0.2000


ans =

     0.2000
```

6. Using the appropriate Matlab commands find and plot the error.

```
>> err=1-y;
plot(t,err)
hold on
plot(t,y,'r')
```


7. Using the appropriate Matlab commands find the exact value of the steady state error.

```
>> err(end)

ans =

   0.8000
```

8. Repeat the previous steps and comment on your results for:

    a. *k*=0.1 and *k*=10 (keep *a* fixed to 5).

    b. *a*=0.5 and *a*=50 (keep *k* fixed to 1).

Exactly the same as before but with different values.

9. Plot the responses of step 7 in one figure, add axes labels and graph title. Each response must be with a different colour.

The previous figures has most of these!

10. For the original system (*k*=1 and *a*=5) find and plot the ramp response and the error when the slope of the input signal is 5.

```
g=tf(5*num,den1); [yr,tr]=step(g,1);
plot(tr,yr); hold on; plot(tr,tr);
plot(tr,5*tr-yr,'r')
```
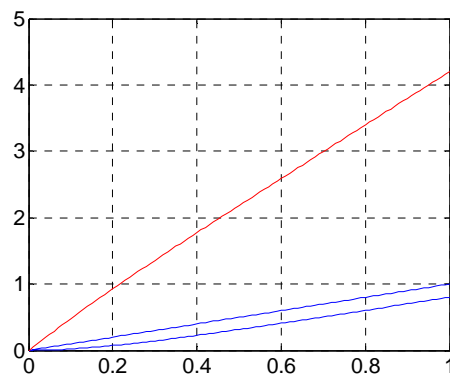

11. Using the appropriate Matlab commands find the exact steady state error.

Obviously the steady state error diverges to infinity so we cannot find an exact numerical value.

12. Using the final value theorem crosscheck your previous answer (for both steady stare response and the steady state error).

Done during lectures.