

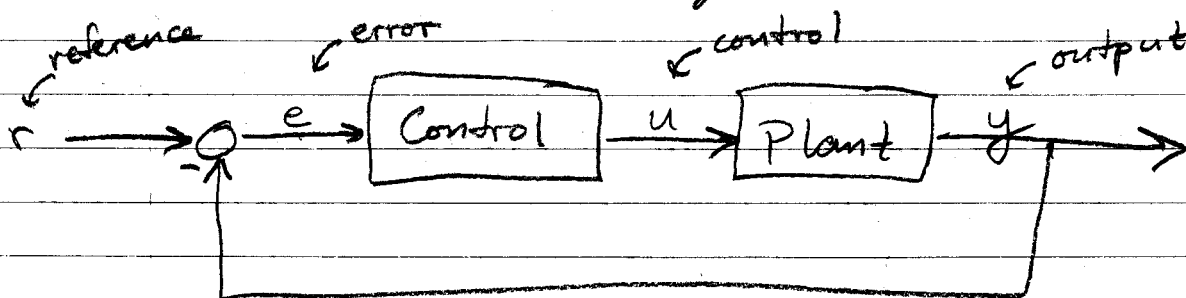
# Simulink Tutorial

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CDS 101/110a

## Simulink

model systems  
~~construct models~~ as block diagrams and simulate them in this form.

### basic block diagram



and what "is" is  
if we specify to Simulink exactly what is in "Control" and "Plant", we can simulate this system in exactly this form

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## How to represent the "Plant"

2 ways: State-Space

Transfer Fcn

use basic 1<sup>st</sup> order system:

$$\begin{aligned} \dot{x} &= Ax + Bu \\ y &= Cx + Du \end{aligned}$$

$$\left. \begin{aligned} \dot{x} &= x + u \\ y &= x \end{aligned} \right\} \Rightarrow \begin{aligned} A &= 1 \\ B &= 1 \\ C &= 1 \\ D &= 0 \end{aligned}$$

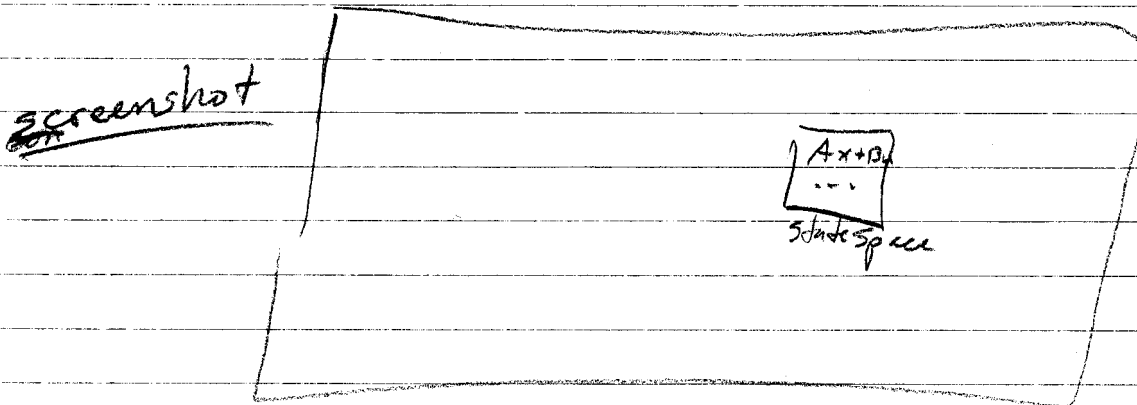
we can observe the entire state

→

to represent this in state space directly,  
use Continuous/State Space

the values of  $A, B, C, D$  are parameters of  
the block

change parameters by double-clicking on  
the block to open the parameter  
dialog box.



~~now~~

To represent this system as a transfer function

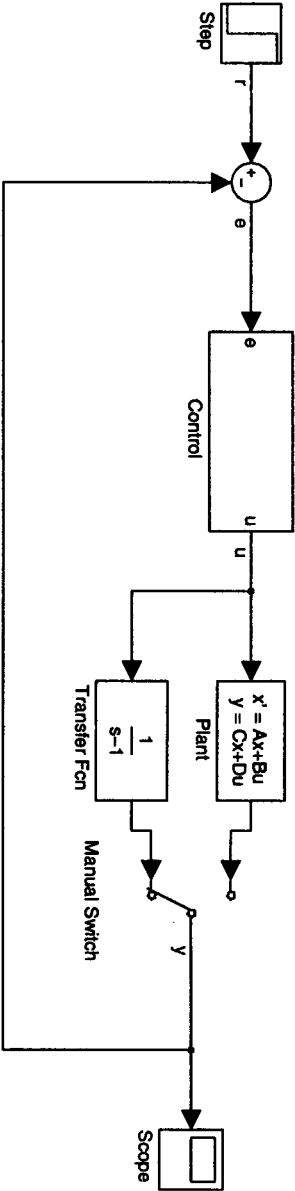
$$\dot{x} = x + u$$

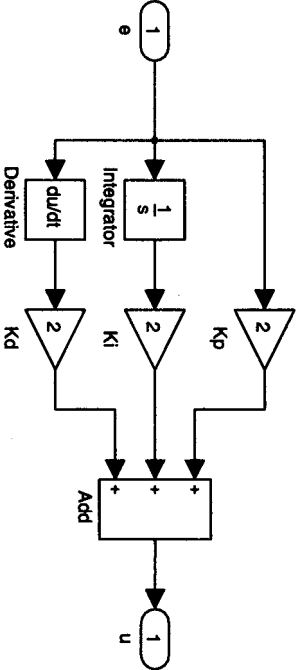
$$s\tilde{x} = \tilde{x} + \tilde{u}$$

$$(s-1)\tilde{x} = \tilde{u}$$

$$\tilde{x} = \boxed{\frac{1}{s-1}} \tilde{u}$$

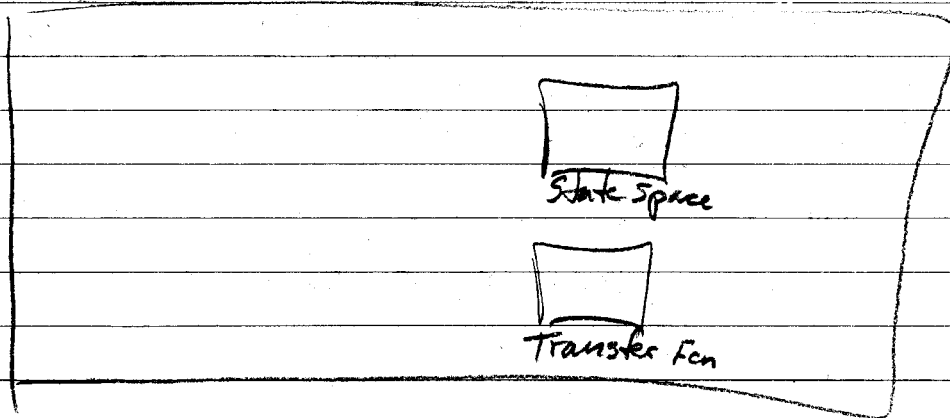
↑  
Transfer function





in Simulink, use a Transfer Fcn block  
parameters are the coefficient vectors of  
the num & denom.

screen  
shot



if we want the system to track a ref,  
we must provide it.

step Response is a convenient choice

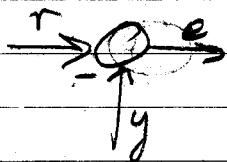
Unit Step block

parameters: ~~step~~ time = 0  
final value = 1

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Implement proportional control

we need an error signal  $r - y$

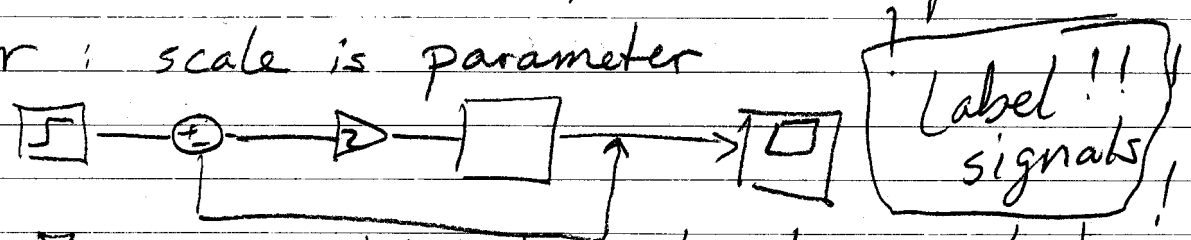


use a summing junction

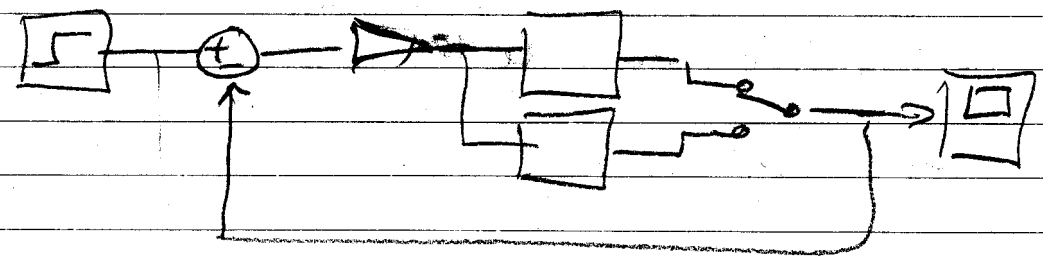


default is /++ , but change to /+-  
to get a subtraction of second input

gain error : scale is parameter



look at output w/ scope - binoculars autoscale  
now, to demonstrate that SS / TF are  
the same, insert a switch for the  
output



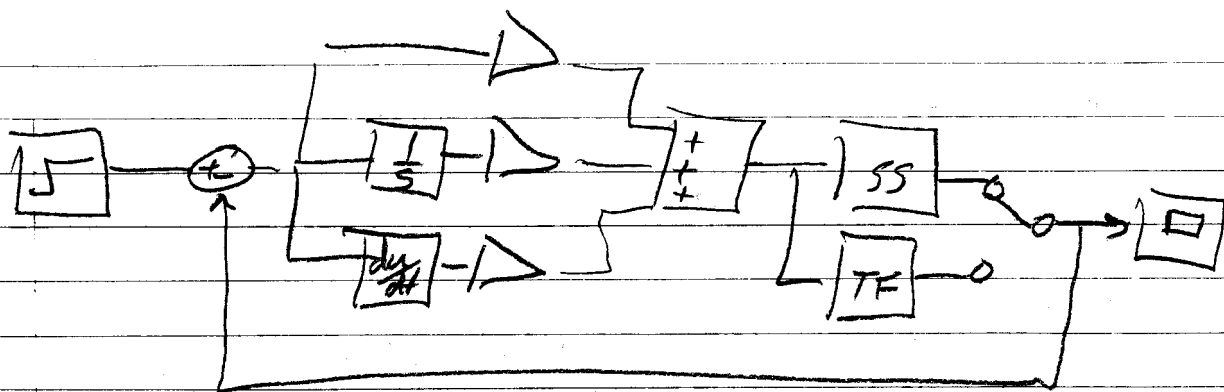
double click on switch to change it.

## PID control

use Continuous / Integrator

(  $\frac{1}{s}$  is reference to Laplace Tfm of integral )

and Continuous / Derivative



~~now we can't really see good behavior~~  
 can't see behavior because  $t = 10s$  is too short

### Configuration Parameters

change Stop Time to vary length of sim  
 make it 20

now we can rescale the scope and see more about the stability

Now make the control a subsystem: this makes the block diagram clearer.

Drag in Ports & Subsystems / Subsystem

Double-click to open the subsystem model

rename In 1 ~~as~~ as error

" Out 1 as control



Notice that corresponding port names  
on subsystem block have changed  
cut/paste the control calculation (PID)  
into the subsystem model

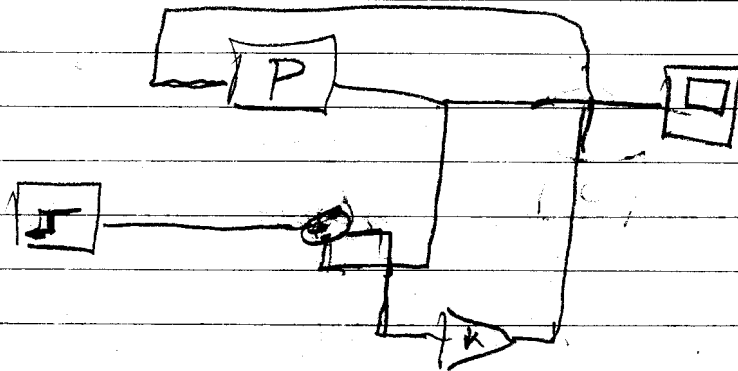
insert subsystem block where the  
control calculation used to be  
Done! (first block diagram!)

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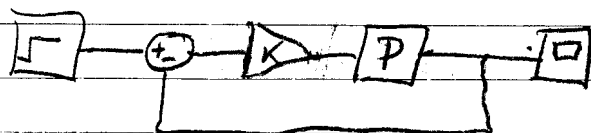
Simulink style

make diagram ~~not~~ resemble <sup>logical</sup> flow of  
information

would not make a block diagram



must take time to make diagrams flow logically





If necessary, Simulink makes tools available to help make the diagram pretty:

- Flip Block
  - Rotate Block
- } ~~under~~ in Format menu

Can also color blocks w/ options in Format menu and in the context menu