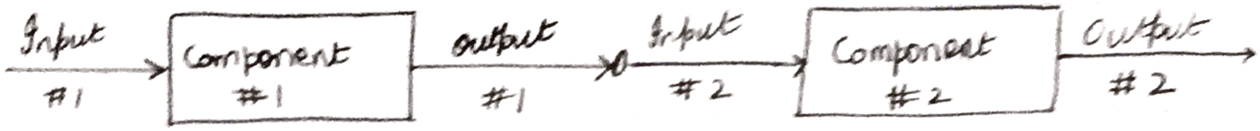
5/01/16

SYDE 352 - Intro to control systems

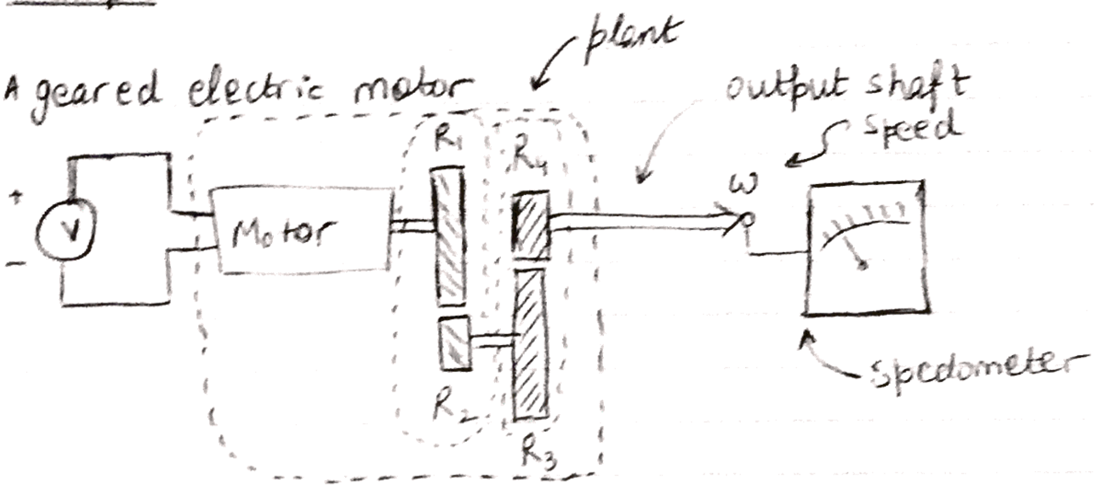
Systems comprised of many components each component has an input & an output.

In block diagram form



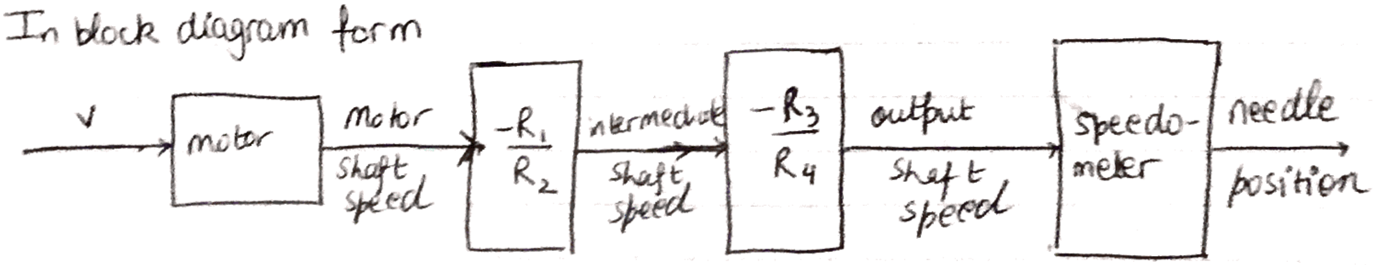
<u>Example</u>

A geared electric motor



actuator - Voltage Source
sensor - speedometer
output - needle position
plant → motor + gear train
input - Voltage

In block diagram form



open loop system, V is independent of the needle position

Example Room temperature control

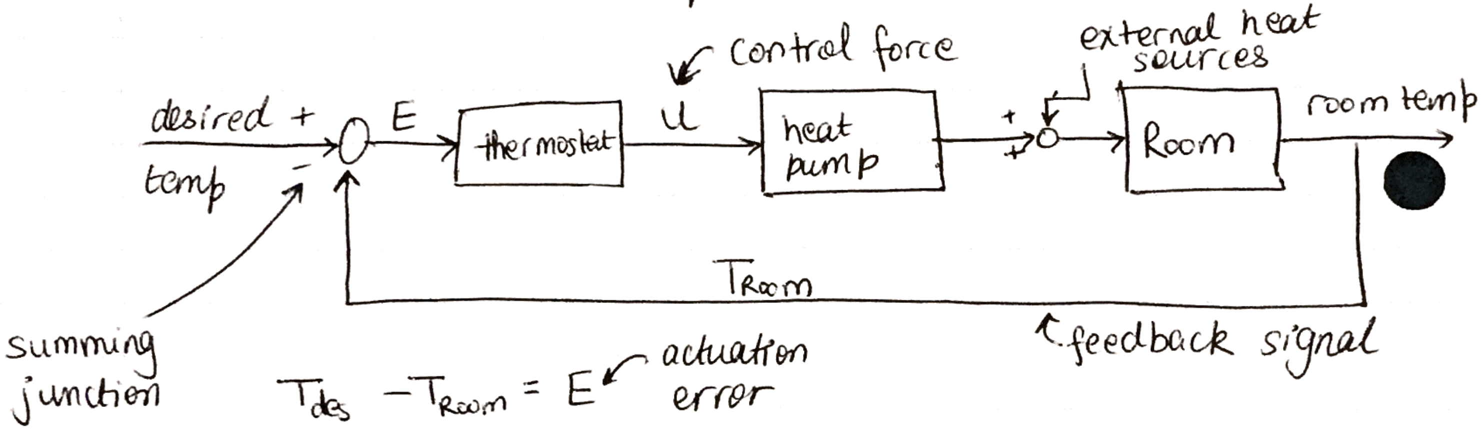
objective - keep a room at a desired temperature

input - the desired temperature

output - the actual room temp

sensor - thermometer

Controller - thermostat ; plant - the room



$T_{des} - T_{Room} = E$ actuation error

Relation b/w E & u is a differential equation

Assume, linear components
- behaviour described by linear ODEs
- coefficients in the ODEs are constant

→ this is a linear time invarient (LTI) system

for LTI systems we use Laplace Transforms to convert ODEs to algebric equations in the complex domain.

Complex Numbers Review

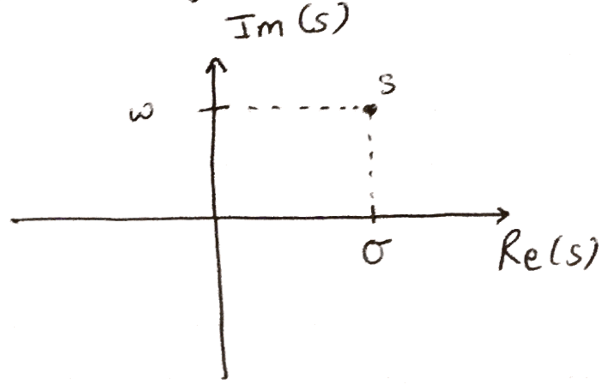
1.) Cartesian Form

$$s = \sigma + j\omega$$

real part, sigma

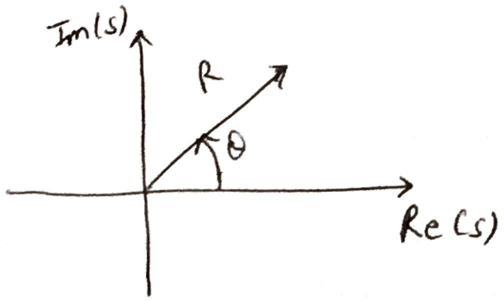
imaginary part, omega

$$j = \sqrt{-1}$$



2) Polar form:

$$s = R(\cos\theta + j\sin\theta)$$



$$R = |s| = \sqrt{\sigma^2 + \omega^2}$$

$$\theta = \tan^{-1}\left(\frac{\omega}{\sigma}\right)$$

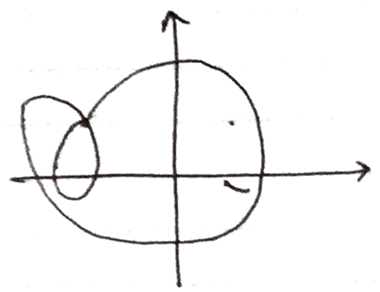
3) Euler form

$$s = Re^{j\theta}$$
$$= R(\cos\theta + j\sin\theta)$$

Complex Functions

$G(s) = Re(G(s)) + j\,Im(G(s))$

1) Single Valued - for each s there is only one value of $G(s)$



2) Analytic -

$G(s)$ is analytic in the region of the s-plane if $G(s)$ & all its derivatives exist
i.e. $G(s) = \frac{1}{s}$ is analytic everywhere except at $s = 0$

3) Singularity
- a pt where $G(s)$ is not analytic

4) Pole - special singularity where for $G(s) = \frac{N(s)}{D(s)}$

values of s where $D(s) = 0$ are poles

Value of s where $N(s) = 0$ are called zeros.

If $\lim_{s \to s_i} [(s - s_i)^r G(s)] = \text{constant} \neq 0$

then $G(s)$ has a ~~ple~~ pole of order r at s_i

Example $G(s) = \frac{s+4}{s^2(s+1)}$ zero at $s = -4$
pole of order 2 at $s = 0$
pole of orde 1 at $s = -1$