Ch 4

① Transfer function for Electric. circuit

- transform all the component into Z(s)
- V_{in}
- V_{out}
- $TF = \frac{V_{out}}{V_{in}}$

$Z_C(s) = \frac{1}{Cs}$

$Z_R(s) = R$

$Z_L(s) = Ls$

② Transfer function for mechanical system

- constuct the diff. equ
- take the Laplace transform
- $TF = \frac{X(s)}{F(s)}$

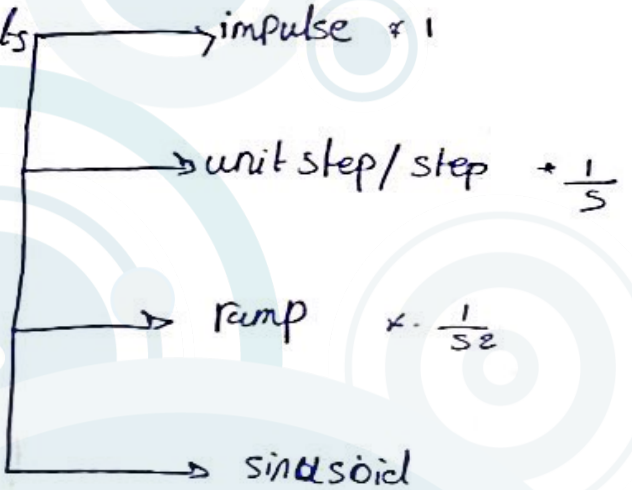
Scanned with CamScanner

Ch5

First order systems

(first+second)

* all systems have these inputs



response

$C(t) = C_{tr}(t) + C_{ss}(t)$

Transfer function of first order

$G(s) = \frac{9}{s+9} \Rightarrow$ where $T = \frac{1}{9}$

$= \frac{1}{Ts+1}$

$T_s = 4T$

$T_r = \frac{2.2}{9}$

Scanned with CamScanner

$$H(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

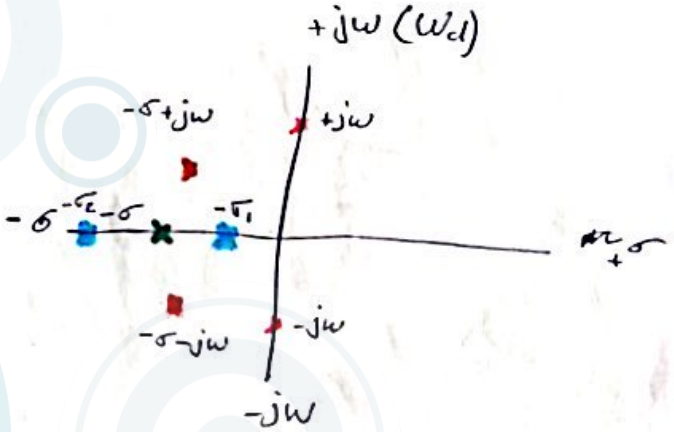
* $\sigma = \zeta\omega_n$

$$\omega_d = \omega_n\sqrt{1-\zeta^2}$$

$$\omega_n^2 = \sigma^2 + \omega_d^2$$

* $\zeta = 0$ undamped → $s_1 = j\omega$, $s_2 = -j\omega$

* $0 < \zeta < 1$ underdamped → $s_1 = -\sigma + j\omega$, $s_2 = -\sigma - j\omega$



* $\zeta = 1$ critically damped → $s_1 = -\sigma$, $s_2 = -\sigma$

* $\zeta > 1$ overdamped → $s_1 = -\sigma_1$, $s_2 = -\sigma_2$

القانون العام

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$T_r = \frac{1.8}{\omega_n}$$

$$\%OS = \%P = \exp\left(-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}\right)$$

$$T_p = \frac{\pi}{\omega_d} = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}}$$

$$T_s = \frac{4}{\sigma} = \frac{4}{\zeta\omega_n}$$

Scanned with CamScanner

Ch 6

* Poles + Zeros

$$G(s) = \frac{s+3}{s(s+2)}$$

* Denominator roots → Poles ($s=0$, $s=-2$)
* Numerator roots → zeros ($s=-3$)
* # of Poles = order for the system

* first order = $\frac{1}{Ts+1}$ $T>0$ stable, $T<0$ unstable

* second order = $\frac{1}{s^2 + a_1 s + a_2}$ stable when $a_1, a_2 > 0$

* 3rd order = $\frac{1}{s^3 + a_1 s^2 + a_2 s + a_3}$ stable when $a_1, a_2, a_3 > 0$ and $a_1 * a_2 > a_3$

* higher order → routh criteria

Scanned with CamScanner

ch 7

① steady-state error

for unit step / step

① $K_p = \lim_{s \to 0} G(s)$ (open loop)

② $E_{ss} = \frac{A}{1 + K_p}$

for ramp

① $K_v = \lim_{s \to 0} s \, G(s)$ (open loop)

$E_{ss} = \frac{A}{K_v}$

E = desired value - output
= reference - output
= $R(s) - H(s)$

Scanned with CamScanner

② PID controllers → K وبنعدل بقيمة For unstable systems بنضيفهم controllers ثم
stable system عشان يصير ال

بسيطة جدًا حسب شو ال controller المطلوب بحطه

- P controller → K_P
- I " → $\frac{K_I}{S}$
- D " → $K_D S$

وبنجمع ال controllers المطلوبين

改善 KAIZEN TEAM

Scanned with CamScanner