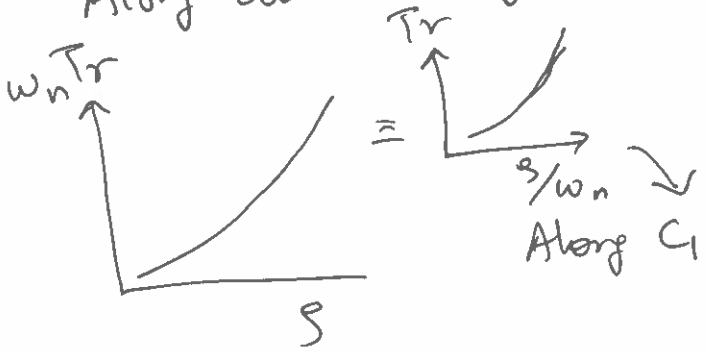
Tut 3: Brief find solutions of some problems 8th Feb 2024 S2

Q-2, Q-3 constant T_s line

T_s const ⇒ real part of root is constant.

Along direction of C_1,



T_p decreases (since $\omega_d \uparrow$)
% OS increases
T_r decreases.

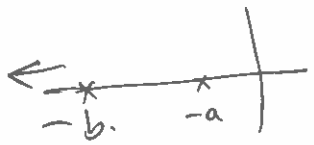
Along C_1; ζ decreases → each one causes ζ & ω_n increases. $T_r \downarrow$.

Q-4c Not possible to meet 3 specifications in general.

Q-5 Step response.

$$\frac{ab}{s(s+a)(s+b)} = \frac{1}{s} + \frac{\left(\frac{-b}{b-a}\right)}{s+a} + \frac{\left(\frac{a}{b-a}\right)}{s+b}$$

$b >> a > 0$



So $\frac{a}{b-a} \to 0$ as $b \to +\infty$.

$\frac{-b}{b-a} \to -1$ as $b \to +\infty$. $\quad \frac{1}{s} + \frac{-1}{s+a} = \frac{a}{(s+a)s}$

$$\frac{ab}{(s+a)(s+b)} \approx \frac{a}{s+a}$$

transfer fn w.r.t. step response after normalizing steady state value.

Q-6: plot 2: take bipropn. 1st order $= \frac{0.4s+1}{s+1}$

Why?

plot 1: clearly 2nd order, underdamped; with one or two zeros. Why?

— Need biprops.

$$\frac{0.4s^2 + cs + 1}{s^2 + s + 1}$$

Need to find $c \in \mathbb{R}$ (within numerator).

....

— contd.

Q-6: plot 2 – contd:

step response $y(t)$ of $G(s) = \dfrac{0.4s^2+cs+1}{s^2+s+1}$

has $Y(s) = \dfrac{0.4s^2+cs+1}{s(s^2+s+1)}$, derivative $\dot{y}(t)$ has Laplace transform $\dfrac{s(0.4s^2+cs+1)}{s(s^2+s+1)}$

$$= \frac{0.4s^2+0.4s+0.4 \quad -0.4s+cs+1-0.4}{s^2+s+1} = 0.4 + \frac{s(c-0.4)+0.6}{s^2+s+1}$$

For IVT for $\dot{y}(0^+)$, pursue further with $\dfrac{s(c-0.4)+0.6}{s^2+s+1}$

& applying IVT, we get $\lim_{t\to 0^+} \dot{y}(0^+) = \lim_{s\to\infty} s\cdot\left(\dfrac{s(c-0.4)+0.6}{s^2+s+1}\right)$

$= c-0.4.$

For initial rise rate $=0$, take $c=0.4$.

Thus plot 2, $G_2(s) = \dfrac{0.4s^2+0.4s+1}{s^2+s+1}$

For plot 9:

First try to get

can be increased to get more overshoot

$\dfrac{4s+6}{s^2+5s+6}$

then multiply by $-\frac{1}{2}$

For plot 9: $G(s) = -\frac{1}{2}\dfrac{(4s+6)}{(s^2+5s+6)}$

Does this guy ↑ OS?

Why?