Examen Parcial 2.

①

$G(s) = \frac{s+28}{s+6}$ $\qquad G_{cL}(s) = \frac{K(s+28)}{s+6+K(s+28)} = \frac{\dots}{s+16}$

$s(1+K) + 6 + K(28) = s+16$

$s + \frac{6+28K}{1+K} = s+16$

$\frac{6+28K}{1+K} = 16$ $\qquad 6+28K = 16+16K$

$(28-16)K = 16-6$

$K = 10/12$

$\underline{K = \emptyset.833}$ //

② $-4.32 \pm 26.82j$

$w_n = \sqrt{(-4.32)^2 + 26.82^2}$

$\underline{w_n = 27.166}$ //

② $e_{ss} = ?$ $\qquad a=16 \quad b=17 \quad c=17$

$P=19 \quad I=6 \quad D=2$

$G(s) = \frac{a}{(s+b)(s+c)}$

Type 1, unit ramp $\quad e_{ss} = \frac{1}{K_v}$

$C(s) = \frac{Ps + I + Ds^2}{s}$ $\qquad K_v = \lim_{s \to \emptyset} sG(s)C(s) = \left(\frac{16}{(17)(17)}\right)(6)$

$r(t) = t$

$K_v = \frac{96}{289}$

$e_{ss} = \frac{289}{96} \approx \underline{3.010}$ //

$a = 11$ poles CL $s = -2(11) \pm 10j$.

④ $N(s) = 10$

$-3a$ $-a$

-33 -11

$$G(s) = \frac{N(s)}{(s+3a)(s+a)} = \frac{10}{(s+33)(s+11)} = \frac{10}{s^2+44s+363}$$

$$G_{CL}(s) = \frac{10K}{s^2+44s+363+10K}$$

$s = -22 \pm 10j$

$(s+22)^2 - (10j)^2 = s^2 + 44s + 484 + 100$

$$\cancel{s^2}+\cancel{44s}+\cancel{363}+10K = \cancel{s^2}+\cancel{44s}+\cancel{363}+221$$

$10K = 221$

$\underline{K = 22.1}$ //

⑤ $a = 9.92$ $b = 24.96$

$-9.92 \pm 24.96j$

$t_p = ?$

$t_p = \pi / \omega_d$

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

$\omega_n = \sqrt{(-9.92)^2 + (24.96)^2} = 26.859$

$\theta = \tan^{-1}\left(\frac{24.96}{-9.92}\right) = -1.1925$

$\zeta = \cos\theta = 0.3693$

$\omega_d = 24.96$

$\underline{t_p = 0.126}$ //

⑥ $e_{ss} = ?$

$$G(s) = \frac{a}{s(s+b)(s+c)}$$

Type 2, unit ramp

$$C(s) = \frac{Ps + I + Ds^2}{s}$$

$\underline{e_{ss} = 0}$ //

$r(t) = t$

⑦

$a=6$ poles in CL

$N(s)=20$ $s=-4\pm10j$

$-3a$ $\quad$ $-a$

-18 $\quad$ -6

$$G(s)=\frac{N(s)}{(s+3a)(s+a)}=\frac{20}{(s+18)(s+6)}=\frac{20}{s^2+24s+108}$$

$s=-4\pm10j$ $\quad G_{CL}(s)=\dfrac{20K}{s^2+24s+108+20K}$

$$(s+4)^2-(10j)^2=\cancel{s^2}+8s+16+100=\cancel{s^2}+24s+108+20K$$

$$-16s+8=20K \quad X$$

Not such gain

⑧

$a=11$ $\quad b=36$ $\quad$ Is it possible to design a PID using the damped oscillations method?

$-11\pm36j$

$\delta\geq0.21$ $\quad \delta=\cos\left(\tan^{-1}\left(\frac{36}{-11}\right)\right)=0.29$ ✓✓

TRUE//

⑨ $a=7$ $\quad b=14$ $\quad N(s)=55$

$C(s)=\dfrac{5(s+z)}{s+p}$ $\quad z=20$ $\quad p=48$ $\quad K_p=?$ $\quad e_{ss}=7\%$

$-7\pm14j$ $\quad \omega_n=\sqrt{7^2+14^2}=7\sqrt{5}$ $\quad e_{ss}=0.07$

$\delta=\cos\left(\tan^{-1}\left(\frac{14}{-7}\right)\right)=\frac{\sqrt{5}}{5}$ $\quad e_{ss}=\dfrac{1}{1+K_p}$

$$G(s)=\frac{N(s)}{s^2+2\omega_n\delta s+\omega_n^2}=\frac{55}{s^2+14s+245}$$

$$C(s)=\frac{5(s+z)}{s+p}=\frac{5(s+20)}{s+48}$$

$$0.07=\frac{1}{1+\left(\frac{55}{245}\right)\left(\frac{5(20)}{48}\right)K_p} \quad 1+\frac{275}{588}K_p=\frac{1}{.07}$$

$$K_p=\frac{588}{275}(13.286) \quad K_p=28.407// \quad \frac{275}{588}K_p=14.286-1$$

(10) $e_{ss} = ?$

$$G(s) = \frac{a}{s(s+b)(s+c)}$$

Type = 1 unit step

$e_{ss} = \emptyset$ //

$C(s) = K$

$r(t) = 1$

(11) $$G(s) = \frac{s-8}{s^6+7s^5+4s^4+5s^3+9s^2+15s+22}$$

$K = 7.45$

$$G_{CL}(s) = \frac{K(s-8)}{s^6+7s^5+4s^4+5s^3+9s^2+15s+22+K(s-8)}$$

$$s^6+7s^5+4s^4+5s^3+9s^2+15s+22 + 7.45s - 59.6 = s^6+7s^5+4s^4+5s^3+9s^2+22.45s - 37.6$$

*matlab inestable

(12) $e_{ss} = ?$ $a = 15$ $b = 10$ $c = 18$ $K = 13$

$$G(s) = \frac{a}{s(s+b)(s+c)}$$

Type 1, unit ramp

$e_{ss} = 1/K_v$

$C(s) = K$

$r(t) = t$

$$K_v = \lim_{s \to \emptyset} s\,G(s)\,C(s) = \left(\frac{15}{10(18)}\right)(13)$$

$K_v = 13/12$ $e_{ss} = \frac{12}{13} \approx \emptyset.923$ //

(13) $a = 14$ $b = 26$

Damped oscillations method?

$-14 \pm 26j$ $\delta \geq 0.21$ $\delta = \cos\left(\tan^{-1}\left(\frac{26}{-14}\right)\right) = 0.474$

TRUE //

(14) $a = 4.24 \quad b = 25.15$

$\omega_d = ?$

$-4.24 \pm 25.15j$

$\omega_n = \sqrt{4.24^2 + 25.15^2}$

$\omega_n = 25.505$

$\delta = \cos\left(\tan^{-1}\left(\frac{25.15}{-4.24}\right)\right) = 0.166$

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

$\omega_d = 25.150$ //

(15) $G(s) = \frac{a}{(s+b)(s+c)}$

$a = 15 \quad b = 10 \quad c = 15 \quad z1 = 39 \quad z2 = 0.017$

$p1 = 57 \quad p2 = 0.004 \quad K = 13$

$C(s) = \frac{K(s+z1)(s+z2)}{(s+p1)(s+p2)}$

Type 0, unit step

$e_{ss} = \frac{1}{1+K_p}$

$r(t) = 1$

$K_p = \lim_{s \to 0} G(s)C(s) = \left(\frac{15}{10(15)}\right)\left(\frac{13(39)(0.017)}{57(0.004)}\right)$

$K_p = 3.7802$

$e_{ss} = \frac{1}{1+K_p} = 0.209$ //

(16) $-a \pm bj \quad a = 4.62 \quad b = 27.06$

$t_{ss} = ? \quad 2\%$

$t_{ss} = \frac{4}{\omega_n \delta}$

$-4.62 \pm 27.06j$

$t_{ss} = 0.866$ //

$\omega_n = \sqrt{(-4.62)^2 + 27.06^2} = 27.4516$

$\delta = \cos\left(\tan^{-1}\left(\frac{27.06}{-4.62}\right)\right) = 0.168$

⑰ $G(s) = \frac{a}{(s+b)(s+c)}$ Type 1, unit step

$C(s) = \frac{Ps + I + Ds^2}{s}$ $e_{ss} = \emptyset$ //

$r(t) = 1$

⑱ Type 1, unit ramp

$G(s) = \frac{a}{s(s+b)(s+c)}$ $a = 10$ $b = 19$ $c = 16$ $K = 11$

$z = 27$ $p = 48$

$C(s) = \frac{K(s+z)}{s+p}$ $e_{ss} = \frac{1}{K_v}$

$r(t) = t$ $K_v = \lim_{s \to \emptyset} sG(s)C(s)$

$e_{ss} = 4.913$ //

$= \left(\frac{10}{19(16)}\right)\left(\frac{11(27)}{48}\right)$

$K_v = \frac{495}{2432}$

⑲ $a = 7$ $b = 7$ $N(s) = 60$ $e_{ss} = ?$

$C(s) = \frac{7(s+z)}{s+p}$ $z = 15$ $r(t) = 1$

$p = 47$

$e_{ss} = \frac{1}{1+K_p}$

$-7 \pm 7j$

$G(s) = \frac{N(s)}{s^2 + 2\omega_n \zeta s + \omega_n^2} = \frac{60}{s^2 + 14s + 98}$ $C(s) = \frac{7(s+15)}{s+47}$

$\omega_n = \sqrt{(-7)^2 + 7^2} = 7\sqrt{2}$

$K_p = \lim G(s)C(s)$

$\zeta = \cos\left(\tan^{-1}\left(\frac{7}{-7}\right)\right) = \frac{\sqrt{2}}{2}$ $K_p = \left(\frac{60}{98}\right)\left(\frac{7(15)}{47}\right)$

$K_p = 450/329$

$e_{ss} = \frac{329}{779} \approx \emptyset.422$ //

(21)

$$G(s) = \frac{s-8}{s^6+7s^5+4s^4+5s^3+9s^2+15s+22}$$

$$C(s) = \frac{4(s+z)}{(s+p)} \quad z=21 \quad p=14$$

$$C(s) = \frac{4(s+21)}{(s+14)} = \frac{4s+84}{s+14}$$

$$s^6+7s^5+4s^4+5s^3+9s^2+19s+106=0$$

*matlab roots

unstable

(22)

$$G(s) = \frac{a}{(s+b)(s+c)} \quad C(s)=K \quad r(t)=t$$

$a=10$ $b=17$ $c=10$ $K=10$

$e_{ss}=?$ Type 0, unit ram $e_{ss}=\infty$

(23) $a=3.5$ $b=17.31$

$-a \pm bj$

$\delta=?$

$$\delta = \cos\left(\tan^{-1}\left(\frac{17.31}{-3.5}\right)\right) = 0.198$$

(24) $r(t) = 1$

$$G(s) = \frac{a}{s(s+b)(s+c)}$$

Unit step, Type 1

$$C(s) = \frac{K(s+z1)(s+z2)}{(s+p1)(s+p2)}$$

$e_{ss} = \emptyset$ //

(25) $$G(s) = \frac{a}{(s+b)(s+c)}$$

Type $\emptyset$, unit step

$$e_{ss} = \frac{1}{1+K_p}$$

$C(s) = K$

$a = 10 \quad b = 16 \quad c = 14 \quad K = 14$

$r(t) = 1$

$$K_p = \lim_{s \to \emptyset} G(s)C(s) = \left(\frac{10}{16(\cancel{14})}\right)(\cancel{14})$$

$e_{ss} = 8/13 = \emptyset.615$ //

$$K_p = \frac{10}{16}$$

(26) $$G(s) = \frac{a}{(s+b)(s+c)} \qquad C(s) = \frac{K(s+z1)(s+z2)}{(s+p1)(\cancel{sp}\ s+p2)} \qquad r(t) = t$$

Unit ramp, type $\emptyset$ $e_{ss} = \infty$

(27) $$G(s) = \frac{a}{(s+b)(s+c)} \qquad C(s) = \frac{K(s+z)}{s+p} \qquad r(t) = 1$$

$a = 18 \quad b = 11 \quad c = 12 \quad z = 25 \quad p = 71 \quad K = 14$

Unit step Type $\emptyset$ $$e_{ss} = \frac{1}{1+K_p} = 0.598$$ /

$$K_p = \lim_{s \to \emptyset} G(s)C(s) = \left(\frac{18}{11(12)}\right)\left(\frac{14(25)}{71}\right) = \emptyset.672$$

(28) $e_{ss} = ?$

$$G(s) = \frac{a}{s(s+b)(s+c)}$$

Unit step Type 1

$e_{ss} = \emptyset$

$$C(s) = \frac{K(s+z)}{s+p}$$

$r(t) = 1$

(29) Type 2, unit step

$e_{ss} = \emptyset$

(30) $$G(s) = \frac{a}{s(s+b)(s+c)}$$

Type 1, unit ram

$$e_{ss} = \frac{1}{K_v}$$

$$C(s) = \frac{K(s+z1)(s+z2)}{(s+p1)(s+p2)}$$

$r(t) = t$

$a = 11 \quad b = 19 \quad c = 18$

$K = 10 \quad z_1 = 29 \quad z_2 = \emptyset.\emptyset 19$

$p_1 = 48 \quad p_2 = \emptyset.\emptyset\emptyset 1$

$$K_v = \lim_{s \to \emptyset} sG(s)C(s) = \left(\frac{11}{19(18)}\right)\left(\frac{10(29)(0.019)}{48(.001)}\right)$$

$K_v = 3.692$ $\quad e_{ss} = \emptyset.271$

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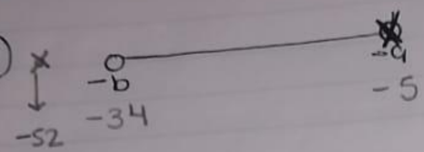

$a=5 \quad b=34$

$s=-52$

32

$$G(s)=\frac{a}{(s+b)(s+c)}$$

$$C(s)=\frac{K(s+z)}{s+p}$$

$r(t)=t$

Unit ramp

type Ø

$\underline{e_{ss}=\infty}$ //