08

PZI 2 - NE
4 - NE

ZI 4 - NE

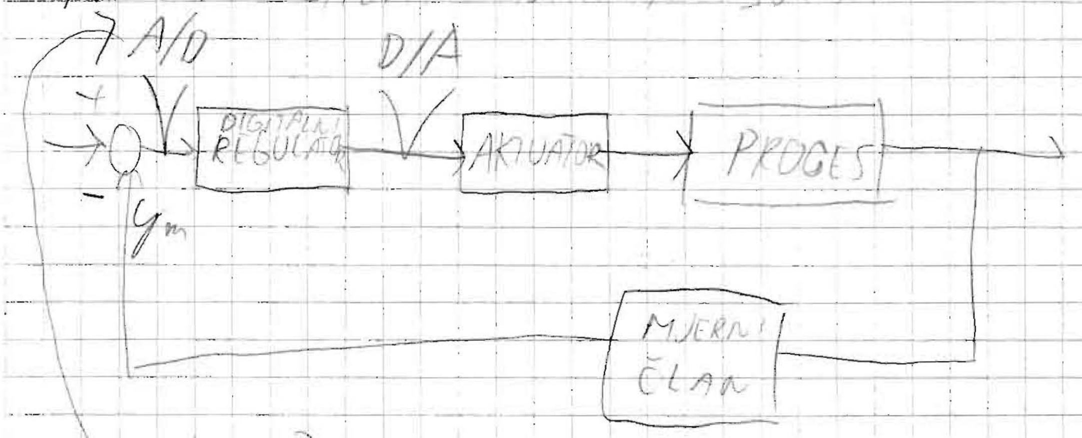
1. PIT cca 10 BOD TEORIJA

I diskretni sustavi upravljanja
II PID regulatori i parametriranje
III

PDF-ove pogledati tek zadnji /2 mailal
integralni kriterij

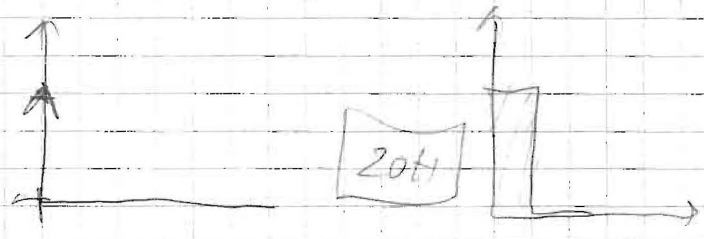
PROOFS → kontinuirani sustavi
REGULATORI → kont /diskretni

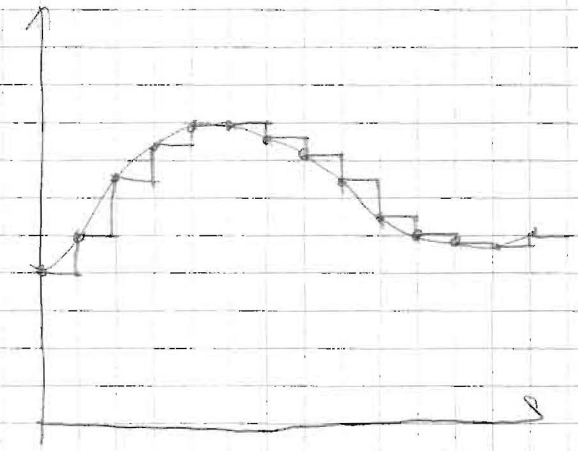
NAČELNA SHEMA DISKRETNOG SUSTAVA



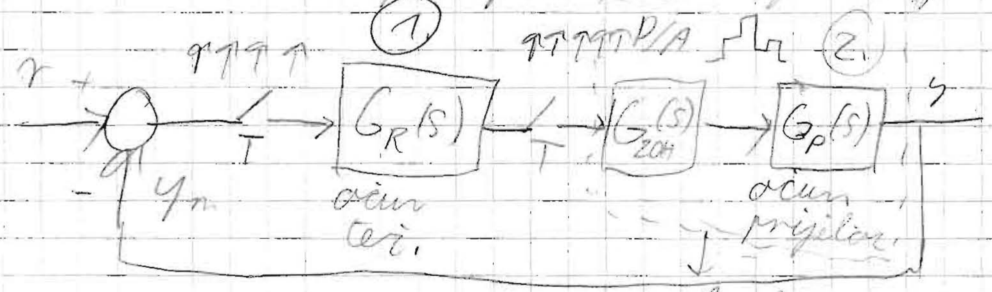
$\omega_f > 2\omega_{max}$
Ny - SHANON FREQ

ZOH ekstrapolator



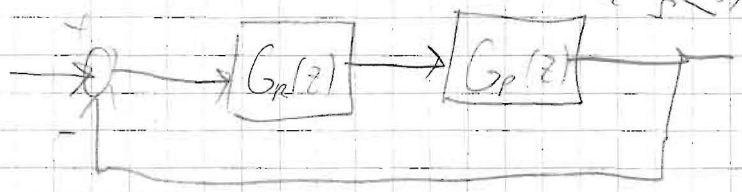


Kako bi smanjili greške smanjiti vrijeme uzorkovanja



→ digitalni sustav upravljanja modeliran u kontinuiranoj dom.

$G_S = \frac{1 - e^{-sT}}{s} G_p(s)$



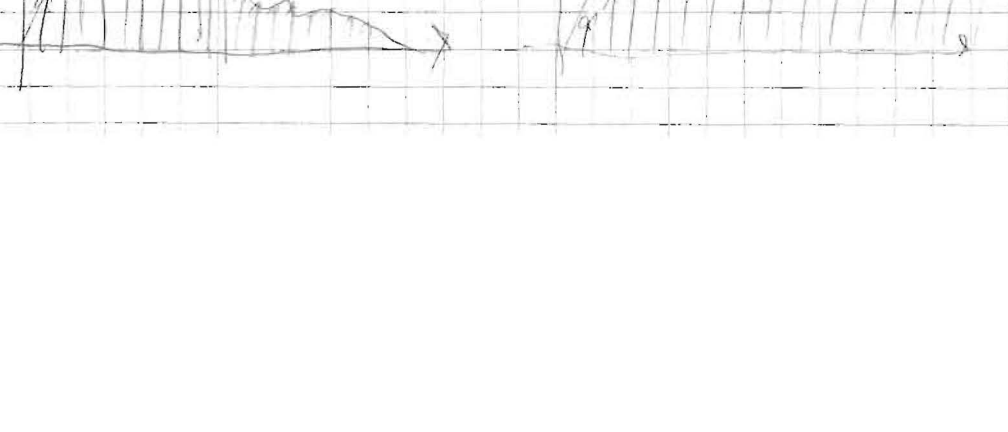
dig. sust. upr. modeliran u diskretnoj dom.

diskretizacija (6 metoda - 1 za ne koristi nas..)

1. IMPULSNA DISKRETIZACIJA

$G(z) = Z\{G(s)\}$

- čuva značajke težinske f-je (odziv na impuls)



2. ZOH DISKRETIZACIJA

- čuva svojstva prijelazne f-je

$$G(z) = (1 - z^{-1})\, \mathcal{Z}\left\{ \frac{G(s)}{s} \right\}$$

~~3.~~ OČUVANJE POLOVA I NULA

- ovu ne koristimo

4. TUSTINOVA RELACIJA

$$G(z) = G(s)\Big|_{s = \frac{2}{T}\frac{z-1}{z+1}}$$

5. EULER UNAPRIJEDNI

$$G(z) = G(s)\Big|_{s = \frac{z-1}{T}}$$

6. EULER UNAZADNI

$$G(z) = G(s)\Big|_{s = \frac{z-1}{zT}}$$

=> bitno znati kad se koja koristi

- $\boxed{\text{5 decimala}}$ kad se računaju diskretizacije

4,5,6. se koristi za emulaciju za regulator NIKAD za procese, samo kad je navedeno. 5,6 se rijetko koristi u praksi

1. Kojiun
mora težit u nulu za $t \to \infty$

2.

3. blokovska shema (1.) mutn dikut

Z ledu iz 15. pred

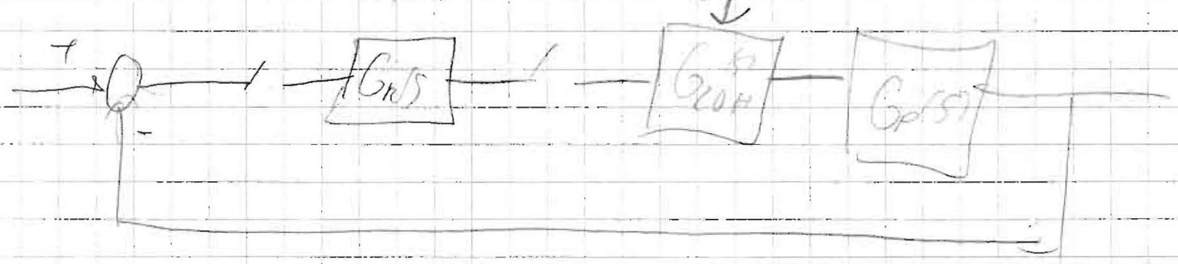
2. pojednostav blokovsku shemu

3.

4. PID reg

$G_R(s) = 0.1 \frac{1+s}{s}$, impulsna

$G_p(s) = \frac{5}{(1+0.3s)(s+1)}$, ZOH $\frac{1-e^{-sT}}{s}$



$G_R(s) = 0.1\left(1 + \frac{1}{s}\right)$

$\frac{1}{s} \to \frac{z}{z-1}$

$1 \to 1$

$G_R(z) = 0.1\left(1 + \frac{z}{z-1}\right) = 0.1 \frac{2z-1}{z-1} = 0.1 \frac{2 - z^{-1}}{1 - z^{-1}} = \frac{U(z)}{E(z)}$

$0.1\left[2E(z) - z^{-1}E(z)\right] = U(z) - U(z)z^{-1}$

$\cancel{0.1\left[k E(k) - (k-1)E(k)\right]}$

$0.1(2e(k) - e(k-1)) + u(k-1) = u(k)$

$$G_p(s) = \frac{50/3}{s(s+\frac{10}{3})(s+1)} = \frac{\quad}{s} - \frac{\quad}{s+1} + \frac{\quad}{s+\frac{10}{3}}$$

2.
$$G_R(z) = 10\,\frac{z-0.4}{z-0.6}$$

$$G_p(z) = 0.04\,\frac{z-0.25}{(z-0.4)(z-0.6)}$$

$$G_0(z) = 0.4\,\frac{z-0.25}{(z-0.6)^2}$$

$$f(z) = z^2 - 1.2z + 0.36 + 0.4z - 0.1$$

$$f(z) = z^2 - 0.8z + 0.26 = 0$$

$$z = \frac{1+w}{1-w}$$

$$f(w) = \left(\frac{1+w}{1-w}\right)^2 - 0.8\,\frac{1+w}{1-w} + 0.26 = 0$$

$$f(w) = (1+2w+w^2) - 0.8(1-w^2) + 0.26(1-2w+w^2)$$

$$f(w) = 2.06w^2 + 1.48w + 0.46 = 0$$

$$z = \frac{1+\Omega\frac{T}{2}}{1-\Omega\frac{T}{2}}$$

$$G_0(\Omega) = \ldots$$

$\Delta\varphi = -\omega_c \frac{T}{2}$ → zmanjšeni fazni osiguranj diskretni zadrž...

$\gamma_d = \gamma_c + \Delta\varphi$

$\sigma_m = 70^\circ - \gamma$ → nadvišenje se poveča za onoliko % za koliko se zmanji fazno osiguranje

ZITHER-NEDIS - pan

JURYEV KRITERIJ

$f(z) = 1 - z + 2z^2 - 3z^3 + 2z^4 = 0$

$f(1) > 0 \qquad f(1) = 1 > 0$

$(-1)^n f(-1) > 0$ n = red sustava

$(-1)^4 f(-1) = 9 > 0$

2. TABLICA

Redak	z^0	z^1	z^2	z^3	z^4	
1	1	-1	2	-3	2	T
2	2	-3	2	-1	1	
n-2 3	-3	5	-1	-1	X	T
4	-1	-1	5	-3	X	
5	8	-11	11	X	X	F
6	11	-11	8	X	X	

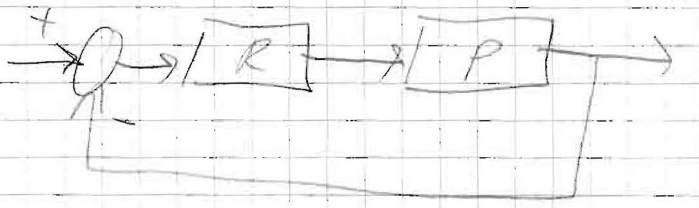
$b_0 \begin{vmatrix} 1 & 2 \\ 2 & 1 \end{vmatrix} = -3 \qquad c_0 = \begin{vmatrix} -3 & -1 \\ -1 & -3 \end{vmatrix} = 8$

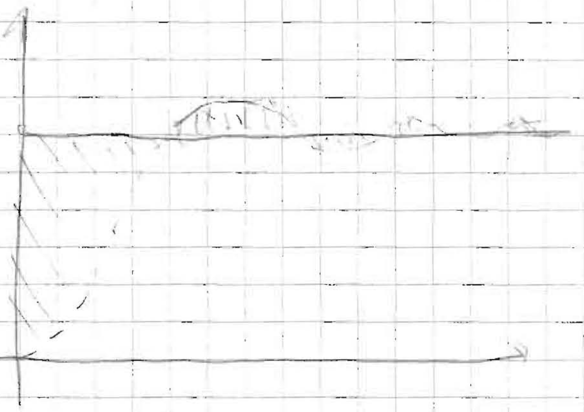
$b_1 \begin{vmatrix} 1 & -3 \\ 2 & -1 \end{vmatrix} = 5 \qquad c_1 = \begin{vmatrix} -3 & -1 \\ -1 & 5 \end{vmatrix} = -11$

$b_2 \begin{vmatrix} 1 & 2 \\ 2 & 2 \end{vmatrix} = -2 \qquad c_2 = \begin{vmatrix} -3 & 5 \\ -1 & -1 \end{vmatrix} = 11$

$b_3 \begin{vmatrix} 1 & -1 \\ 2 & -3 \end{vmatrix} = -1$

INTEGRALNI KRITERIJI





min(e) min(povr. e)

$J = \int_0^\infty e \, dt$

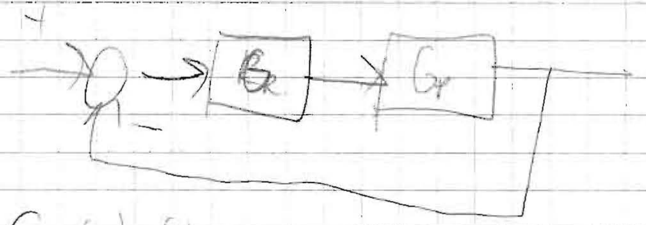
$J = \int_0^\infty e^2 \, dt \rightarrow$ ne skaliranje, ... podatak

$J = \int f(e)\,dt$ = e many ... [illegible]

$I_k = \int_0^\infty f_k[e(t), u(t)]\,dt$ integral ~~k~~ kvadratna [illegible]

od 7 reda ... samo za $\underline{ISE}$ $\int e^2 dt$

$\boxed{1.}$



$G_R(s) = K_R$

$G_P(s) = \frac{K_P}{s(1+T_P s)^2}$

$K_P = 2 \quad T_P = 0.5\,s$

1. naći $E(s)$ u obliku

$$E(s) = \frac{c_{n-1} s^{n-1} \ldots + c_1 s^1 + c_0}{s^n + d_{n-1} s^{n-1} + \ldots + d_1 s^1 + d_0}$$

i odredit koeficijente c_i i d_i

$$E(s) = \frac{R(s)}{1+G_0(s)} = \frac{R(s)}{1+G_R(s)G_P(s)} =$$

$$E(s) = \frac{1}{s} \cdot \frac{1}{1 + \frac{2K_R}{0{,}25 s (s+2)^2}} = \frac{0{,}25 s^3 + s^2 + s}{0{,}25 s^4 + s^3 + s^2 + 2K_R s}$$

$$= \frac{0{,}25 s^2 + s + 1}{0{,}25 s^3 + s^2 + s + 2K_R}$$

$c_0 = 1 \qquad d_0 = 2K_R$

$c_1 = 1 \qquad d_1 = 1$

$c_2 = 0{,}25 \qquad d_2 = 1$

$\qquad\qquad d_3 = 0{,}25$

2. odredit f-ju $I_{3,n}$ → ISE kriterij ↓ red sustava

$$I_{3,3} = \frac{3K_R + 2}{4K_R(2-K_R)}$$

3. PARCIJALNE DERIVACIJE

$$\frac{\partial I_{3,3}}{\partial K_R} = \frac{3}{4K_R(2-K_R)} + (3K_R+2) \ldots$$

$$= \frac{1{,}5K_R^2 + 2K_R - 2}{K_R^2(K_R-2)} = 0$$

$$K_R = \frac{2}{3}$$

~~$K_R = -$ NEKAJ~~ jer je zadano $K_R > 0$