1

$$\mathcal{L}\{\delta(t)\} = 1 \qquad \mathcal{L}\{1(t)\} = \frac{1}{s} \qquad \mathcal{L}\{e^{2t}\} = \frac{1}{s-2}$$

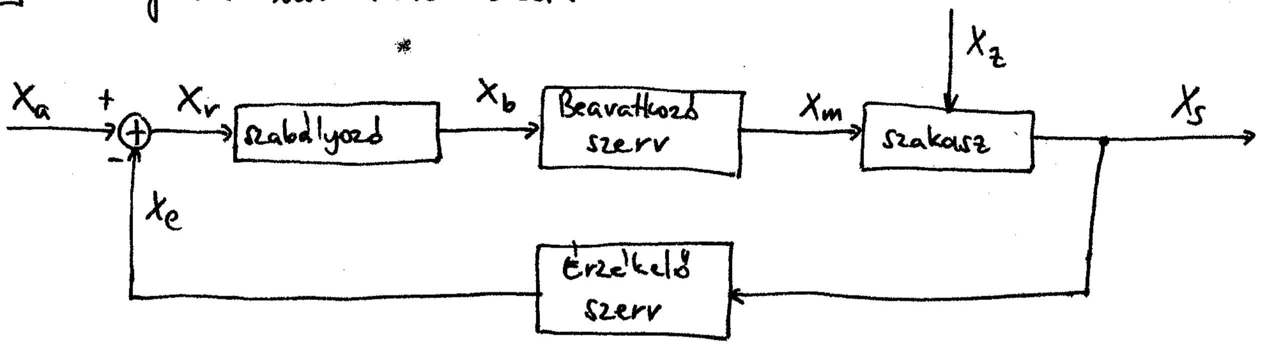
$$\mathcal{L}\{t \cdot e^{3t}\} = \frac{1}{(s-3)^2}$$

2

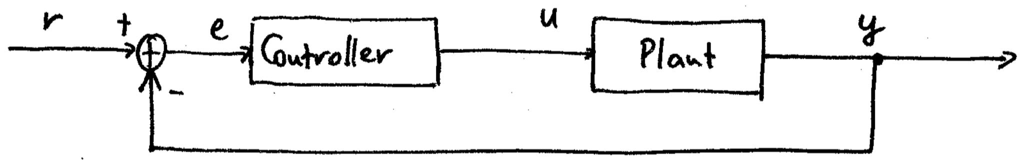
$$\mathcal{L}\{f(t)\} = F(s) \qquad \mathcal{L}\{f'(t)\} = s \cdot F(s) - F(0)$$

$$\mathcal{L}\left\{\int_0^{\tau} f(\tau)\,d\tau\right\} = \frac{F(s)}{s}$$

3 szabályozási kör blokkvázlata

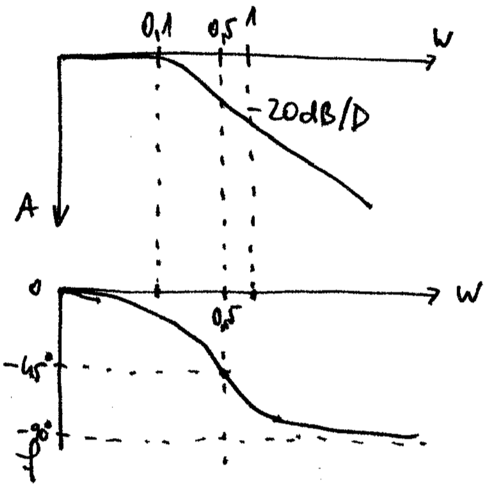


összevonva:



4 egytárolós tag

$$W(s) = \frac{1}{1+T \cdot s} \qquad p = -\frac{1}{T}$$



$$|A(\omega)|_{dB} = 20 \lg \frac{1}{\sqrt{1+(\omega T)^2}}$$

$$\varphi(\omega) = -\operatorname{arctg}(\omega T)$$

$$\omega = \frac{1}{T} \to \varphi = -45°$$

$$\omega = \frac{1}{10T} \to \varphi = -5°$$

$$\omega = \frac{10}{T} \to \varphi = -85°$$

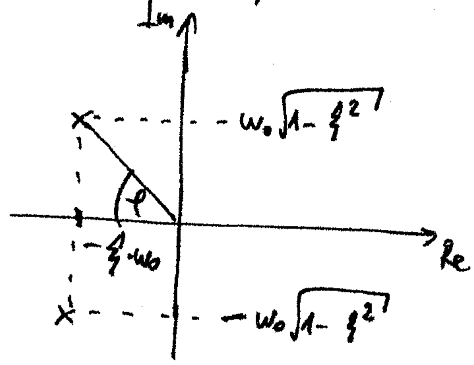
$\boxed{5}$ egytárolós tag átmeneti fgv

$$W(s) = \frac{1}{1+sT} = \frac{1}{T} \cdot \frac{1}{s+\frac{1}{T}} \qquad Y(s) = W(s)\cdot U(s) = \frac{1}{s} \cdot \frac{1}{T} \cdot \frac{1}{s+\frac{1}{T}}$$

$$u(t) = 1(t) \rightarrow U(s) = \frac{1}{s} \qquad \mathcal{L}^{-1}\{Y(s)\} = \frac{1}{T} \cdot \mathcal{L}^{-1}\left\{ \frac{T}{s} - \frac{1}{s+\frac{1}{T}} \right\}$$

$$\underline{v(t) = 1(t) - e^{-\frac{t}{T}}}$$

$\boxed{6}$ kéttárolós tag átviteli fgv, pzmap



$$W(s) = \frac{1}{1+2\cdot\xi\cdot T\cdot s + T^2 s^2} = \frac{\omega_0^2}{\omega_0^2 + 2\cdot\xi\cdot\omega_0\cdot s + s^2}$$

$$s_{1,2} = -\xi\omega_0 \pm j\omega_0\sqrt{1-\xi^2}$$

rezonancia van, ha $0 \leq \xi \leq \frac{\sqrt{2}}{2}$

túllövés van, ha $0 \leq \xi < 1$

$\boxed{7}$ kéttárolós tag átmeneti fgv

$$v(t) = 1 - \frac{e^{-\xi\omega_0 t}}{\sqrt{1-\xi^2}} \sin\left(\omega_0\sqrt{1-\xi^2}\, t + \arccos\xi\right)$$

$$T_m = \frac{\pi}{\omega_0\sqrt{1-\xi^2}}$$

$$\Delta v = v(T_m) - 1 = e^{\frac{-\pi\xi}{\sqrt{1-\xi^2}}}$$

$\boxed{8}$ kéttárolós tag átmeneti fgv

$$T_{\alpha\%} = \frac{\ln\frac{100}{\alpha}}{\sigma_e}$$

$\boxed{9}$ kéttárolós tag általános átviteli fgv

$$s_{1,2} = -\frac{1}{\sqrt{2}} \pm j\frac{1}{\sqrt{2}} \qquad s_{1,2} = -\xi\omega_0 \pm j\omega_0\sqrt{1-\xi^2} \qquad \omega_0 = \frac{1}{T}$$

$$\frac{1}{\sqrt{2}} = \xi\cdot\frac{1}{T} \qquad \frac{1}{\sqrt{2}} = \frac{1}{T}\sqrt{1-\xi^2} \qquad \underline{\xi = \frac{1}{\sqrt{2}}} \quad \underline{T = 1}$$

10 folytonosidejű LTI állapotegyenlete

$$\dot{X} = A \cdot X + B \cdot u \qquad s \cdot X(s) = A \cdot X(s) + B \cdot U(s) \qquad W(s) = \frac{Y(s)}{U(s)}$$

$$Y = C \cdot X + D \cdot u \qquad Y(s) = C \cdot X(s) + D \cdot U(s)$$

$$U(s) = (sI - A) \cdot X(s) \qquad W(s) = C \cdot (sI - A)^{-1} \cdot B + D$$

$s_i \rightarrow W(s)$ pólusa
$\Updownarrow$
$\underline{\underline{A}}$ sajátértéke

11 $W(s) = \dfrac{2}{s+10}$

$\underline{s_1 = -10}$ – pólus

$$V(s) = \frac{2}{s(s+10)} = \frac{0{,}2}{s} - \frac{0{,}2}{s+10}$$

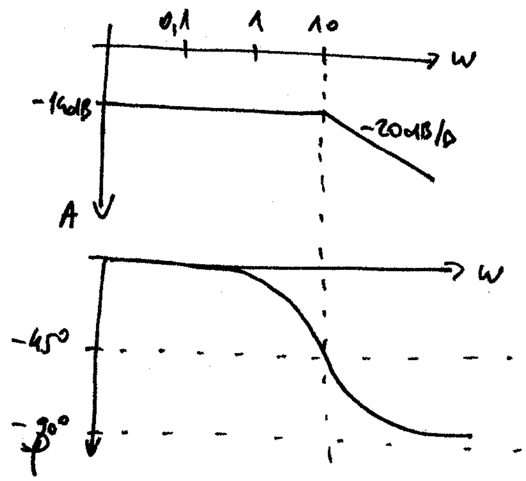
$\underline{v(t) = 0{,}2 \cdot 1(t) - 0{,}2\, e^{-\frac{t}{T_0}} \cdot 1(t)}$ – átmeneti fgv

$\underline{dc = 0{,}2}$ – stat. erősítés

zpk k-ja az átviteli ($w(t)$) fgv konstansát adja, míg a stat. erősítés az átmeneti fgv ($v(t)$) végértékét adja

12 $W(s) = \dfrac{2}{s+10} \rightarrow \dfrac{1}{T} = 10 \rightarrow \underline{T = 0{,}1}$ $\quad \omega_0 = 10$

$$\varphi(\omega) = -\operatorname{arctg}(\omega T)$$



13 $W(s) = \dfrac{s+1}{s^2 + \sqrt{2}\, s + 1}$

$\underline{s_{z_1} = -1}$

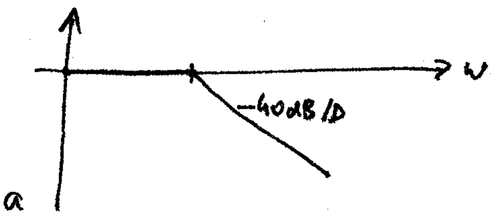
$\underline{s_{p_{1,2}} = -\frac{1}{\sqrt{2}} \pm j \frac{1}{\sqrt{2}}} = -\xi \frac{1}{T} \pm j \frac{1}{T} \sqrt{1 - \xi^2}$

$\underline{T = 1} \qquad \underline{\xi = \frac{1}{\sqrt{2}}}$

14 $W(s) = \dfrac{1}{s^2 + \sqrt{2}s + 1}$

$\varphi(\omega = 0) = 0°$

$\varphi(\omega = \infty) = -k \cdot 90° = -180°$



15 $\begin{pmatrix} \dot{x}_1 \\ \dot{x}_2 \end{pmatrix} = \begin{bmatrix} -1 & 2 \\ 1 & 0 \end{bmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 1 \\ 0 \end{pmatrix} \cdot u$

$y = x_1$

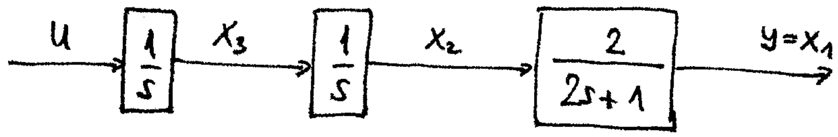
$(-1-\lambda)(-\lambda) - 2 = 0$

$\lambda^2 + \lambda - 2 = 0$

$\lambda_1 = -2 = s_{p1}$

$\lambda_2 = 1 = s_{p2}$

16



$\dot{x}_3 = u$

$\dot{x}_2 = x_3$

$y = x_1$

$\dot{x}_1 = -0{,}5x_1 + x_2$

$W(s) = \dfrac{2}{s^2(2s+1)}$

$s_{p1} = s_{p2} = 0$

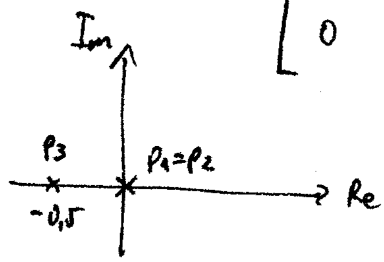
$s_{p3} = -\dfrac{1}{2}$

$A = \begin{bmatrix} -0{,}5 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$

$(-0{,}5-\lambda)(-\lambda)(-\lambda) = 0$

$\lambda^3 + 0{,}5\lambda^2 = 0$

$\lambda_1 = \lambda_2 = 0 \qquad \lambda_3 = -0{,}5$



17

állapottér (ss): $\dot{x} = Ax + Bu$ ss2tf

$y = C \cdot x + D \cdot u$ ss2zp

átviteli fgv (tf): racionális tört alakban $\dfrac{b_0 s^m + b_1 \cdot s^{m-1} + \ldots + b_m}{s^n + a_1 \cdot s^{n-1} + \ldots + a_n}$ $(m<n)$ tf2ss tf2zp

átviteli fgv (zpk) gyöktényezős $k \dfrac{\prod^{m}(s - z_i)}{\prod^{n}(s - p_i)}$ zp2tf zp2ss