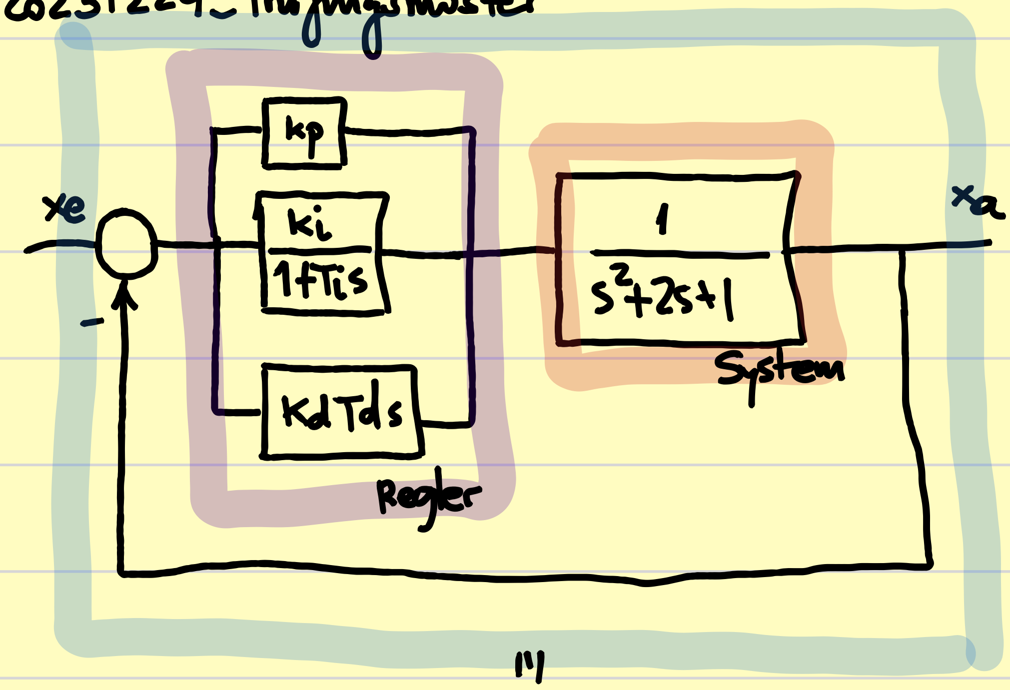
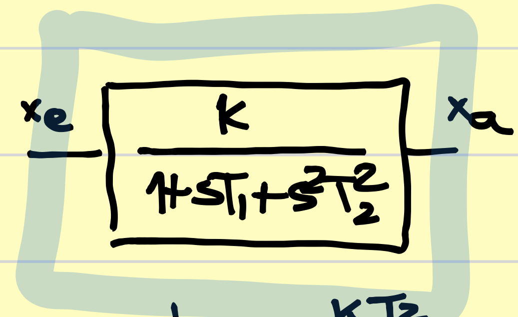
2. 20231224_Prüfungsmuster



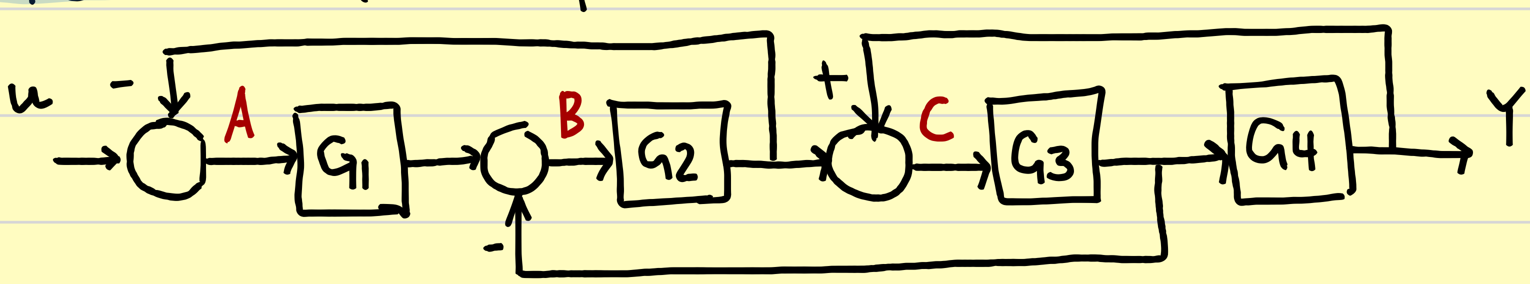


$$\text{Überschw.} = \frac{KT_2}{T_1}$$

$$G(s) = \frac{G_R \cdot H(s)}{1 + G_R H(s)}$$

$$G_R = K_p + \frac{K_i}{1+T_i s} + K_d T_d s$$

Blockschaltbild Beispiel:



Was ist die Übertragungsfunktion $G(s)$?

$$Y = C \cdot G_3 \cdot G_4 \quad (1)$$

$$C = B \cdot G_2 + Y \quad (2)$$

$$B = A \cdot G_1 - C \cdot G_3 \quad (3)$$

$$A = U - B \cdot G_2 \quad (4)$$

$(3)+(4) \rightarrow \quad B = (u - BG_2)G_1 - C \cdot G_3$

$$B + BG_1G_2 = uG_1 - CG_3$$

$$B(1+G_1G_2) = uG_1 - CG_3$$

$$B = \frac{G_1}{1+G_1G_2}u - \frac{G_3}{1+G_1G_2}C \qquad (5)$$

$(5)+(2) \longrightarrow$

$$C = B \cdot G_2 + Y \overset{(2)}{=}$$

$$C = \frac{G_1G_2}{1+G_1G_2}u - \frac{G_2G_3}{1+G_1G_2}C + Y$$

$$C + \frac{G_2G_3}{1+G_1G_2}C = \frac{G_1G_2}{1+G_1G_2}u + Y$$

$$C\left(1 + \frac{G_2G_3}{1+G_1G_2}\right) = \frac{G_1G_2}{1+G_1G_2}u + Y$$

$$C\left(\frac{1+G_1G_2+G_2G_3}{1+G_1G_2}\right) = \frac{G_1G_2}{1+G_1G_2}u + Y$$

$$C = \frac{G_1G_2}{1+G_1G_2+G_2G_3}u + \frac{1+G_1G_2}{1+G_1G_2+G_2G_3}Y \qquad (6)$$

$(6)+(1)$

$$Y \overset{(1)}{=} C \cdot G_3 \cdot G_4 =$$

$$\overset{(6)}{=} \frac{G_1G_2G_3G_4}{1+G_1G_2+G_2G_3}u + \frac{(1+G_1G_2)G_3G_4}{1+G_1G_2+G_2G_3}Y$$

$$Y\left(1-\frac{(1+G_1G_2)(G_3G_4)}{1+G_1G_2+G_2G_3}\right)=\frac{G_1G_2G_3G_4}{1+G_1G_2+G_2G_3}U$$

$$Y\left(\frac{1+G_1G_2+G_2G_3-G_3G_4-G_1G_2G_3G_4}{1+G_1G_2+G_2G_3}\right)=\frac{G_1G_2G_3G_4}{1+G_1G_2+G_2G_3}U$$

$$\boxed{G(s)=\frac{Y}{U}=\frac{G_1G_2G_3G_4}{1+G_1G_2+G_2G_3-G_3G_4-G_1G_2G_3G_4}}$$

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3. NICKDAMPFER . F16

$$G(s)=\frac{-0'1137s-0'0705}{s^2+1'5189s+2'1303}$$

a) Berechnen Sie die Pol- & Nullstellen, Eigenfrequenz & Dämpfung.

Zählerpolynom: $-0'1137s-0'0705=0 \rightarrow s=-0'6201$

Nennerpolynom: $s^2+1'5189s+2'1303=0 \rightarrow$

$$\rightarrow s=\frac{-1'5189\pm\sqrt{1'5189^2-4.2'303}}{2}= \begin{cases}-0'7594+j\,1'2464\\ -0'7594-j\,1'2464\end{cases}$$

$$G(s) = \frac{-0'1137s - 0'0705}{2'1303} \cdot \frac{1}{1 + \frac{1'5189}{2'1303}s + \frac{1}{2'1303}s^2}$$

$$T_2^2 = \frac{1}{2'1303}$$

$$\omega_E = \frac{1}{T_2} = 1'4596\, s^{-1}$$

$$D = \frac{1'5189}{2 \cdot \omega_E} = 0'52$$

b) Eigenfrequenz & Dämpfung mit Regelkreis.

$$G(s) = \frac{k \cdot \frac{-0'1137s - 0'0705}{s^2 + 1'5189s + 2'1303}}{1 - k \cdot \frac{-0'1137s - 0'0705}{s^2 + 1'5189s + 2'1303}} =$$

$$= \frac{k \cdot \frac{-0'1137s - 0'0705}{s^2 + 1'5189s + 2'1303}}{\frac{s^2 + 1'5189s + 2'1303 + 0'1137ks + 0'0705k}{s^2 + 1'5189s + 2'1303}} =$$

$$= k \cdot \frac{-0'1137s - 0'0705}{s^2 + (1'5189 + 0'1137k) + (2'1303 + 0'0705k)} =$$

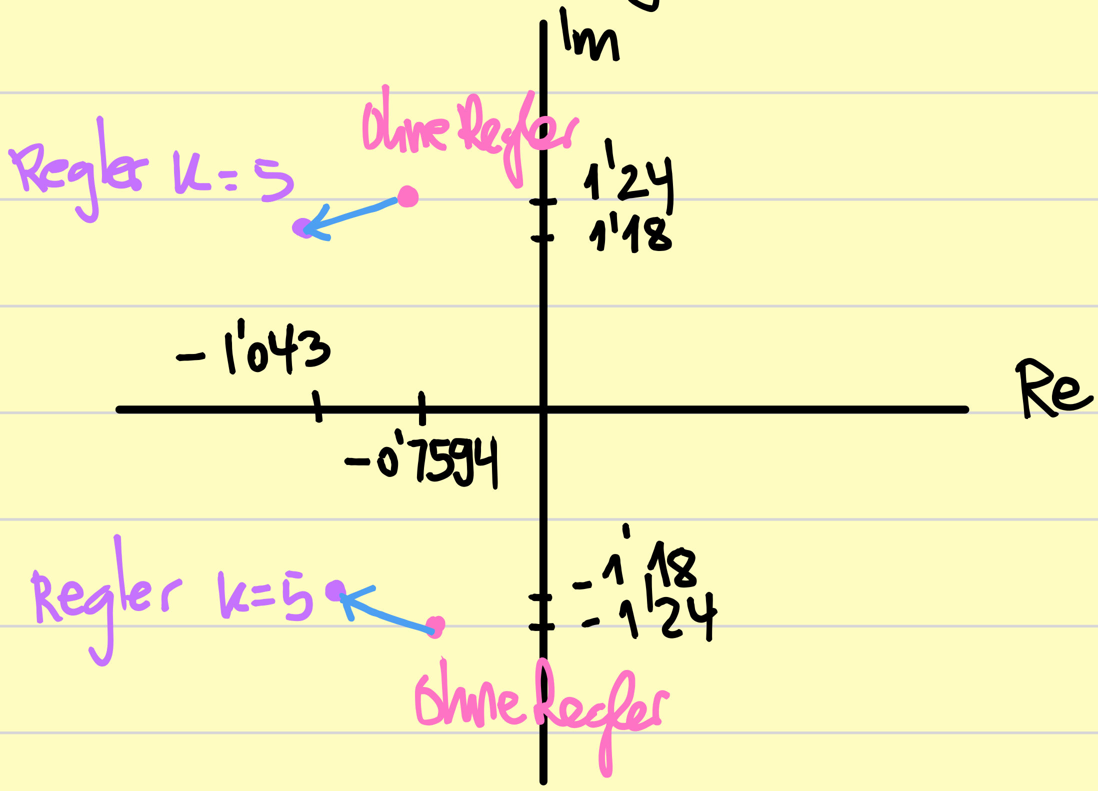
$$= \frac{k}{2'1303 + 0'0705k} \cdot \frac{-0'1137s - 0'0705}{1 + \frac{1'5189 + 0'1137k}{2'1303 + 0'0705k}s + \frac{s^2}{2'1303 + 0'0705k}}$$

c) $k = 5$

Polstellen des geregelten Systems:

$$0 = s^2 + (1'5189 + 0'1137 \cdot K)s + (2'1303 + 0'0705 \cdot K) \xrightarrow{K=5}$$

$$\rightarrow \cdots \rightarrow s = \begin{cases} -1'043 + j\,1'1805 \\ -1'043 - j\,1'1805 \end{cases}$$



$$\boxed{\begin{array}{ll} \omega_E = 1'5757\ s^{-1} & D = 0'66 \\ \text{Regler } K=5 & \text{Regler } K=5 \\ \vee & \vee \\ \omega_E = 1'4596\ s^{-1} & D = 0'52 \\ \text{ohne Regler} & \text{ohne Regler} \end{array}}$$