Testatprüfung 2 LRS FS 2015

① a) $G_W = \frac{Y}{W} = \frac{G_0}{1+G_0} = \frac{\frac{k}{(1+s)^2}}{1+\frac{k}{(1+s)^2}} = \frac{k}{(1+s)^2+k} = \underline{\frac{K}{s^2+2s+1+K}}$

$G_e = \frac{E}{W} = \frac{1}{1+G_0} = \frac{1}{1+\frac{k}{(1+s)^2}} = \frac{(1+s)^2}{(1+s)^2+k} = \underline{\underline{\frac{(1+s)^2}{s^2+2s+1+k}}}$

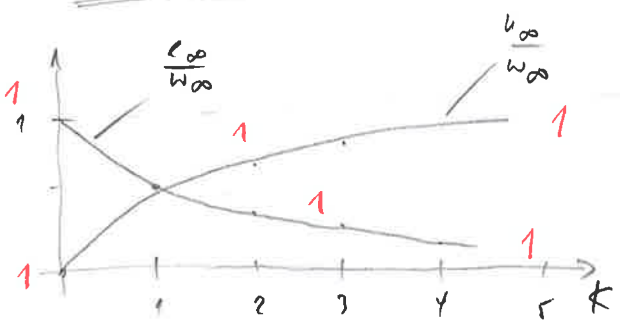
b) $e_\infty = \lim_{s\to 0} s\cdot E(s) = \lim_{s\to 0} s\cdot G_e\cdot\frac{1}{s} = \lim_{s\to 0} G_e = \frac{1}{1+K} \overset{!}{<} 0{,}01$

$100 < 1+k$

$\underline{\underline{99 < k}}$

c) $\underline{\underline{e_\infty = \frac{1}{1+k}\cdot w_\infty}}$

$\underline{\underline{y_\infty = k\cdot e_\infty = \frac{k}{1+k}\cdot w_\infty}}$



② a) $G(s) = \frac{(1+s)(1+10s)}{s^2}\cdot 1$

b) $G(s) = \frac{1}{s(1+0{,}005s)^2}\cdot 10$

c) $G(s) = \frac{s}{(1+s)^2}\cdot 1$

③ a) siehe Blatt Ⓐ

b) $|G(0)| = |G(\infty)| = \underline{\underline{0}}$ $(-\infty dB)$

$|G(j\omega)|_{max}$ bei $\omega \approx \underline{\underline{0{,}1}}$

$|G(j1)| \approx \underline{\underline{-14dB}}$

c) $\underline{\text{Bandpass filter}}$

④ a) Strecke $\frac{2(1+0{,}5s)}{s^2+2s+2}$: PT_2 mit Nullstelle 1

Regler K_p : Proportionalregler 1

b) Nullstellen : $1+0{,}5s=0$

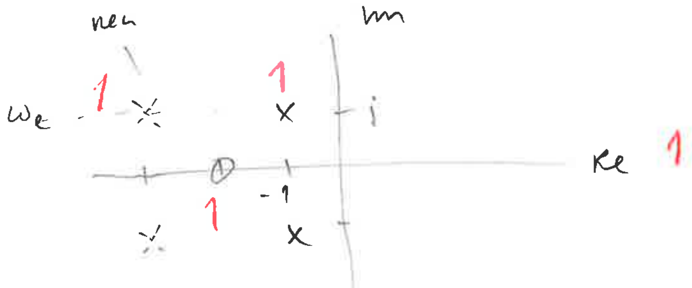
$\underline{\underline{s=-2}}$ 1

Pole : $s^2+2s+2=0$ 1

$s_{1,2}=-1\pm\frac{1}{2}\sqrt{4-8}=\underline{\underline{-1\pm j}}$ 1 1

$$\left.\begin{array}{l} s^2+2s+2 \\ s^2+2D\omega_0 s+\omega_0^2 \end{array}\right\} \quad \begin{array}{l} \underline{\underline{\omega_0=\sqrt{2}}} \approx 1{,}414 \\ \underline{\underline{D=\frac{1}{\sqrt{2}}}} \approx 0{,}707 \end{array}$$

1 1 1



c) $G_w=\frac{G_0}{1+G_0}$ 1

$$G_w=\frac{2K_p(1+0{,}5s)}{2K_p(1+0{,}5s)+s^2+2s+2}=\underline{\underline{\frac{2K_p(1+0{,}5s)}{s^2+(K_p+2)s+(2K_p+2)}}}$$ 1

d) $N(s)=s^2+6s+10$

Pole : $s^2+6s+10=0 \Rightarrow s_{1,2}=-3\pm\frac{1}{2}\sqrt{36-40}$ 1 1

$\underline{\underline{s_{1,2}=-3\pm j}}$ 1

$\omega_{0_{neu}}=\underline{\underline{\sqrt{10}}}\approx 3{,}16$ 1

$D_{neu}=\underline{\underline{\frac{3}{\sqrt{10}}}}\approx 0{,}948$ 1

e) $k_p + 2 \overset{!}{=} 6$ 1
$2k_p + 2 \overset{!}{=} 10$ $\Big\} \Rightarrow \underline{\underline{k_p = 4}}$ 1

f) Einschwingzeit : Pole des offenen Kreises sind näher bei imaginärer 1 Achse ⇒ langsamer 1

Überschwingen : Dämpfung des offenen 1 Kreises ist kleiner ⇒ stärkeres Überschwingen. 1

Einschwingfrequenz : ω_e 1 bleibt gleich 1

(5) a) siehe Blatt (R)

b) für 1 $\varphi_r = 60° \Rightarrow \omega_D$ 1 ≈ 1 $\underline{K \approx 1 \text{ resp } 0dB}$ 1

c) φ_r : Bedingung für ω_D : $|G(j\omega_D)| = 1$

$\frac{K}{\omega_D} = 1 \Rightarrow \underline{\omega_D = K}$ 1

$\varphi_r = \angle G(j\omega_D) + 180°$ 1

$\varphi_r = -90° + \angle e^{-sT} + 180°$ 1 $= -\omega_D T \cdot \frac{180°}{\pi} + 90°$

$\underline{\varphi_r = 90° - KT \cdot \frac{180°}{\pi}}$ 1

d) A_r : Bedingung für ω_π : $\angle G(j\omega_\pi) = -180°$ 1

$-90° - \omega_\pi \cdot T \cdot \frac{180°}{\pi} = -180°$ 1

$\omega_\pi \cdot T \cdot \frac{180°}{\pi} = 90°$

$\omega_\pi = \frac{\pi}{2T}$ 1

$A_r = \frac{1}{|G(j\omega_\pi)|}$ 1 $= \frac{\omega_\pi}{K}$ 1 $= \frac{\frac{\pi}{2T}}{K} = \underline{\underline{\frac{\pi}{2KT}}}$ 1

⑥ a)

$$G = \underset{1}{0{,}5} + \frac{1}{s} + 1{,}5\,s \quad 1$$

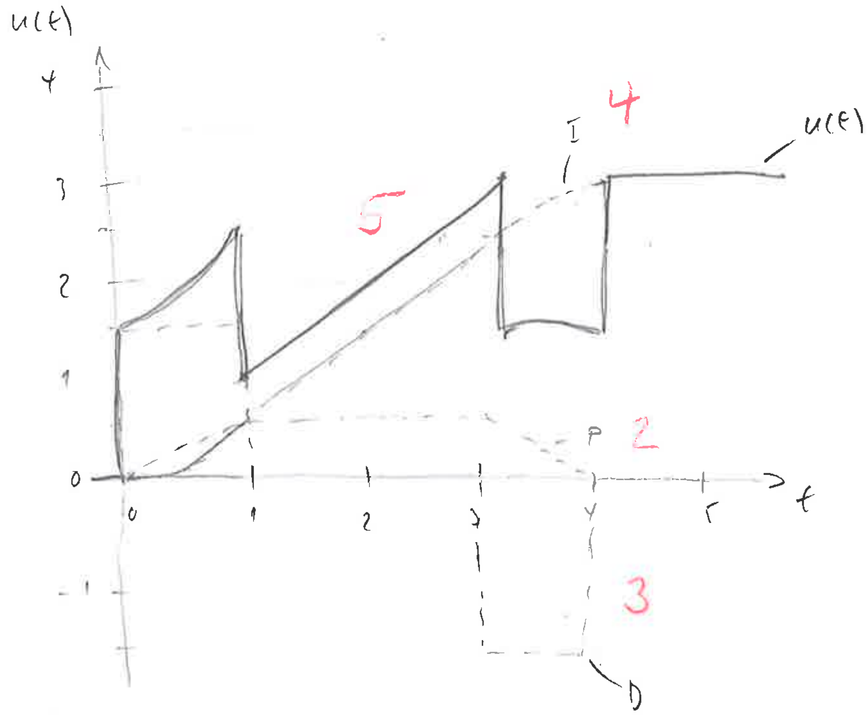
$$G = \frac{1{,}5s^2 + 0{,}5s + 1}{s} \quad 1$$

PID Regler 1

Pole : $s = 0$ 1

Nullstellen : $s_{1,2} = \overset{1}{-\frac{0{,}5}{3}} \pm \frac{1}{3}\sqrt{0{,}25 - 6} \approx \overset{1}{-0{,}1\bar{6} \pm j\,0{,}799}$

b)



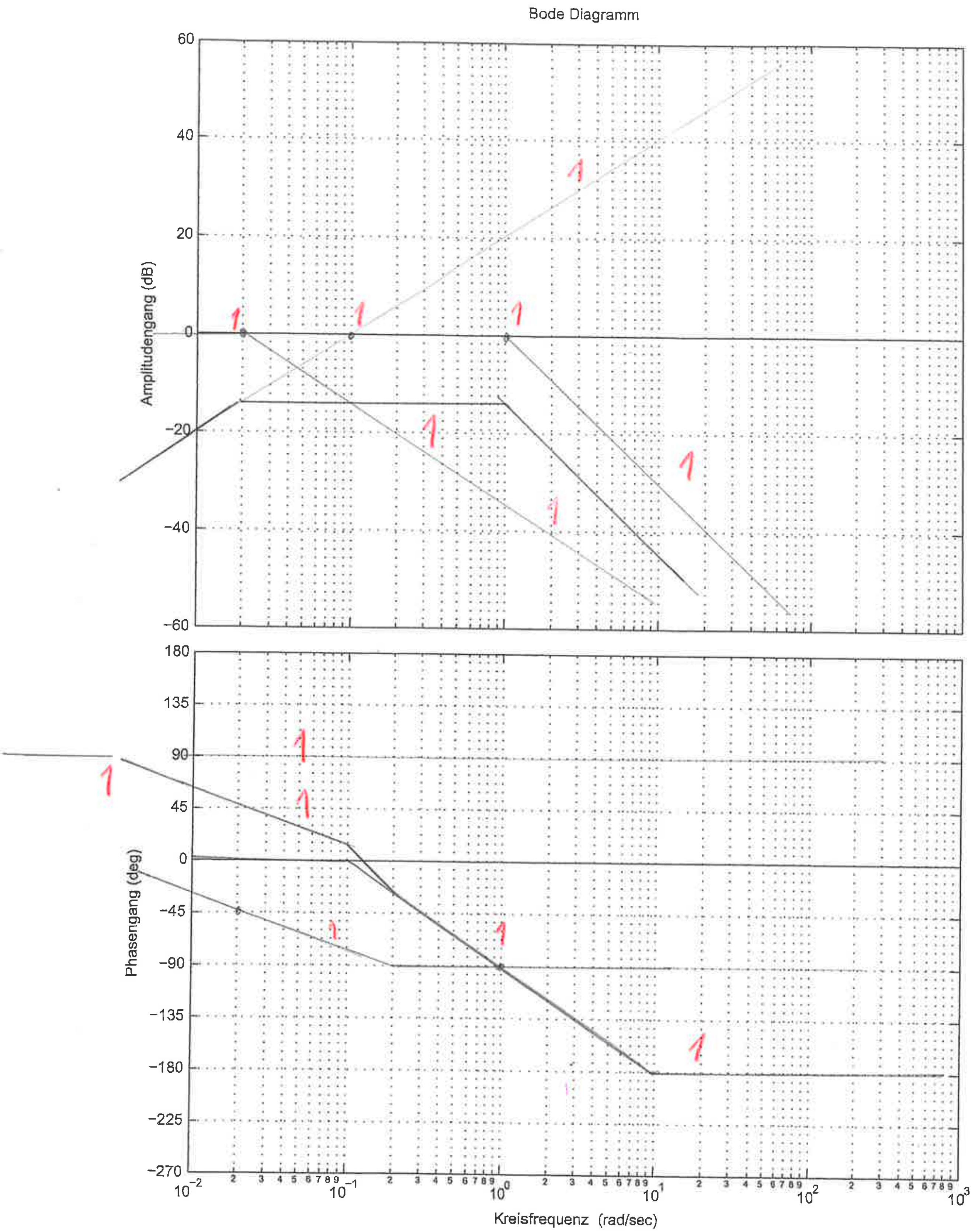
(A)

$$G(s) = \frac{K \cdot s}{(1+sT_1)^2 \cdot (1+sT_2)}$$

$K = 10$

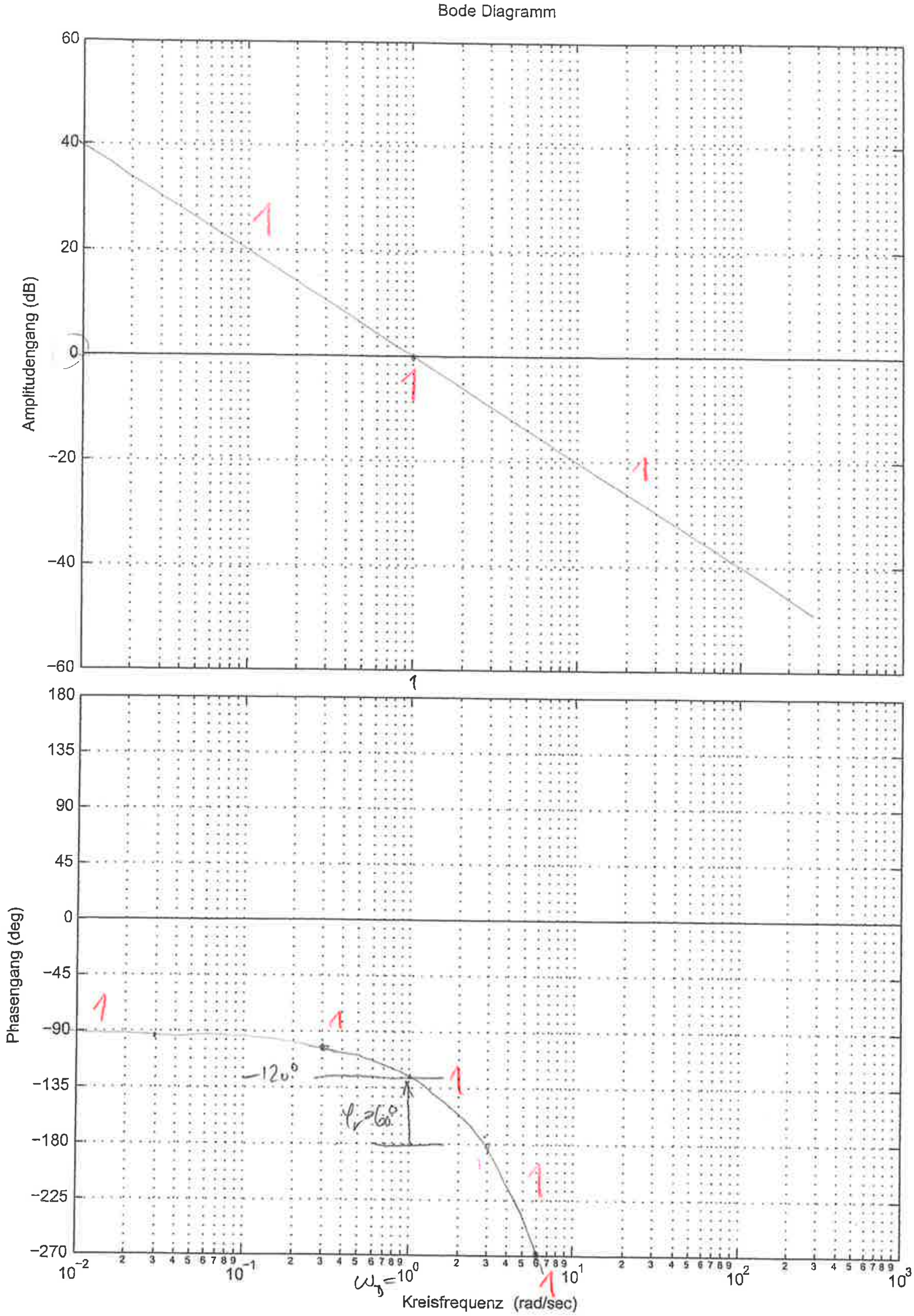
$T_1 = 1$

$T_2 = 50$



(B)

$$G = K \frac{e^{-sT}}{s} \qquad T = 0{,}5 \qquad K = 1$$



$$\angle e^{-sT} = -\omega T = -\omega \cdot 0{,}5 \; [\mathrm{rad}]$$

$$-\frac{\omega \cdot 90}{\pi} \; [^\circ]$$