2. Versuch: Regelungstechnik - Versuchsvorbereitung

$$F_S(s) = \frac{2}{(1+s)(1+2s)}$$

1) $$F_S(s) = \frac{2}{(1+s)(1+2s)} = \frac{2}{1+3s+2s^2} = \frac{1}{\frac{1}{2}+\frac{3}{2}s+s^2}$$

$$\Rightarrow 2D\omega_0 = \frac{3}{2} \Rightarrow D\omega_0 = \frac{3}{4}, \quad D = \frac{1}{\sqrt{2}} \text{ (Angabe)}$$

$$\Rightarrow \omega_0 = \frac{3}{4}\cdot\sqrt{2}$$

$$F(s) = \frac{K_p \cdot F_S}{1 + K_p \cdot F_S} = \frac{K_p}{\frac{1}{2}+K_p+\frac{3}{2}s+s^2} \quad \left(\begin{array}{c}\text{für geschl.}\\ \text{Regelkreise}\end{array}\right)$$

$$\frac{1}{2}+K_p = \omega_0^2 \Rightarrow \frac{1}{2}+K_p = \left(\frac{3}{4}\sqrt{2}\right)^2$$

$$\frac{1}{2}+K_p = \frac{9}{8} \Rightarrow K_p = \frac{5}{8}$$

$$F(s) = \frac{\frac{5}{8}}{\frac{9}{8}+\frac{3}{2}s+s^2}$$

2) $$x_a(t\to\infty) = \lim_{s\to 0}\left[s \cdot F(s) \cdot \underbrace{x_e(s)}_{=\frac{1}{s}}\right] = \lim_{s\to 0}\left[F(s)\right]$$

$$= \lim_{s\to 0}\left[\frac{\frac{5}{8}}{\frac{9}{8}+\frac{3}{2}s+s^2}\right] = \frac{\frac{5}{8}}{\frac{9}{8}} = \frac{5}{9}$$

$$y(\infty) = \left(1-\frac{5}{9}\right)\cdot K_P = \frac{5}{18}$$

3) Regeldifferenz:

$$\lim_{t\to\infty}(x_d(t)) = \lim_{s\to 0} s\cdot x(s) = 0$$

$$\lim_{t\to\infty}(x(t)) = \lim_{s\to 0} s\cdot G(s)\cdot\frac{1}{s} = 1$$

$$\Rightarrow \quad Y\cdot\frac{2}{1+3s+2s^2}\bigg|_{s=0} = 1$$

$$y\cdot 2 = 1 \Rightarrow y = \frac{1}{2}$$

4) $F_o(s) = F_R\cdot F_S = \left(\frac{K_I}{s}+K_p\right)\cdot\frac{2}{1+3s+2s^2}$

$$= \frac{\left(\frac{K_I}{s}+K_p\right)\cdot 2}{1+3s+2s^2}$$

$$F(s) = \frac{\frac{2K_pK_I}{s+3s^2+2s^3}}{1+\frac{2K_pK_I}{s+3s^2+2s^3}} = \frac{2K_pK_I}{3s^2+s+2s^3+2K_pK_I}$$

$$K_p = \frac{T_M}{2K_{ps}\cdot T_E} = \frac{1}{2}$$

5) $\frac{K_I}{s}+K_p = \frac{K_I+sK_p}{s}$

$$\frac{K_I+sK_p}{s}\cdot\frac{2}{(1+s)(1+2s)} = \frac{\frac{1}{2}K_p\left(\frac{K_I}{\frac{1}{2}K_p}+2s\right)}{s}\cdot\frac{2}{(1+s)(1+2s)}$$

$$\frac{K_I}{\frac{1}{2}K_p} = 1 \quad\Rightarrow\quad K_I = \frac{1}{2}K_p$$

$$\frac{\frac{1}{2}K_p}{s}\cdot\frac{2}{1+s} = \frac{K_p}{s+s^2}$$

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

$$\boxed{K_P = \omega_0^2} \qquad \boxed{2 D \omega_0 = 1} \qquad D = \frac{1}{\sqrt{2}}$$

$$\Rightarrow 2 \cdot \frac{1}{\sqrt{2}} \cdot \omega_0 = 1 \Rightarrow K_P = \frac{1}{2}, K_I = \frac{1}{4}$$

$$\omega_0 = \frac{\sqrt{2}}{2}$$

b) $$F_R = \frac{(1+T_1 s)(1+T_2 s)}{s(1+T_D s)}$$

$$F_S = \frac{2}{(1+s)(1+2s)}$$

$$F_0 = F_R \cdot F_S = \frac{(1+T_1 s)(1+T_2 s)}{s(1+0{,}1s)} \cdot \frac{2}{(1+s)(1+2s)}$$

$$G_R(s) = \frac{Y(s)}{x_d(s)} = \frac{K_P(1+T_N s)(1+T_U s)}{T_N s \cdot (1+T_1 s)} = \frac{(1+s)(1+2s)}{s(1+0{,}1s)}$$

$$\Rightarrow T_N = 1, K_R = 1$$

T_V, gewählt $= 2$

$$F_0(s) = \frac{(1+s)(1+2s)}{s(1+0{,}1s)} \cdot \frac{2}{(1+s)(1+2s)} = \frac{2}{s(1+0{,}1s)}$$

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

7) $$F(s) = \frac{K_p \frac{2}{s+0,1s^2}}{1+\frac{2K_p}{s+0,1s^2}} = \frac{2K_p}{s+0,1s^2+2K_p}$$

$$= \frac{20K_p}{20K_p+10s+s^2}$$

$$10 = 2D\omega_0 \Rightarrow 10 = \frac{2}{\sqrt{2}}\cdot\omega_0 \Rightarrow \omega_0 = 5\sqrt{2}$$

$$K_p \cdot 20 = (5\sqrt{2})^2 \Rightarrow K_p \cdot 20 = 50 \Rightarrow K_p = 2,5$$

$$\Rightarrow F(s) = \frac{50}{50+10s+s^2}$$