2) PT1, Proportional

a)

offener Kreis: $(K \cdot V \mp D) \cdot P = G_0(s) = (K(s) V(s) - D(s)) \cdot P(s)$

Führungs: $\frac{Y}{W}$, $R = D = 0$, $(W - Y) K V P = Y$

stör: $\frac{Y}{d}$, $R = W = 0$, $(-Y \cdot K V - D) \cdot P = Y$

messfehler: $\frac{Y}{r}$, $W = D = 0$, $-(Y + R) \cdot K V P = Y$

⊢

Führungs:

$(W - Y) \cdot K V P = Y \qquad Y = K V P W - K V P Y \quad | : Y$

$1 = K V P \cdot \frac{W}{Y} - K V P \quad | + K V P$

$1 + K V P = K V P \cdot \frac{W}{Y} \quad | : K V P$

$\frac{1 + K V P}{K V P} = \frac{W}{Y}$

$$\boxed{\frac{Y}{W} = \frac{K V P}{1 + K V P}}$$

⊢

stör:

$(-Y K V - d) \cdot P = Y \qquad Y = -P Y K V - P d \quad | : Y$

$1 = -P K V - P \cdot \frac{d}{Y} \quad | + P K V$

$1 + P K V = -P \frac{d}{Y} \quad | : -P$

$\frac{1 + P K V}{-P} = \frac{d}{Y}$

$$\boxed{\frac{Y}{d} = \frac{-P}{1 + P K V}}$$

⊢

Messfehler:

$-(y+r)\cdot kvp = y \qquad y = -kvp\,y - kvp\,r \quad | : y$

$1 = -kvp - kvp\,\frac{r}{y} \quad | + kvp$

$1 + kvp = -kvp\cdot\frac{r}{y} \quad | : -kvp$

$$\frac{1+kvp}{-kvp} = \frac{r}{y}$$

$$\boxed{\frac{y}{r} = \frac{-kvp}{1+kvp}}$$

b)

1) $D = R = 0 \Rightarrow$ Führungs

$$\frac{y}{w} = \frac{KVP}{1+KVP} \qquad KVP = 10\cdot\frac{1}{s}\cdot\frac{1}{s+2} = \frac{10}{s^2+2s}$$

$$\frac{y}{w} = \frac{\left(\frac{10}{s^2+2s}\right)}{1+\left(\frac{10}{s^2+2s}\right)} = \frac{11}{\frac{s^2+2s}{s^2+2s}+\frac{10}{s^2+2s}}$$

$$= \frac{\left(\frac{10}{s^2+2s}\right)}{\left(\frac{s^2+2s+10}{s^2+2s}\right)} = \left(\frac{10}{s^2+2s}\right)\cdot\left(\frac{s^2+2s}{s^2+2s+10}\right)$$

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

$$\boxed{\begin{aligned} num &= 10 \\ det &= 1 \quad 2 \quad 10 \end{aligned}}$$

b) 2)

$R = W = 0 \Rightarrow$ stör

$$\frac{Y}{D} = \frac{-P}{1+PKV} = \frac{\left(\frac{-1}{s+2}\right)}{1+\frac{10}{s^2+2s}}$$

$$= \frac{//}{\frac{s^2+2s}{s^2+2s}+\frac{10}{s^2+2s}} = \frac{\left(\frac{-1}{s+2}\right)}{\left(\frac{s^2+2s+10}{s^2+2s}\right)}$$

$$= \left(\frac{-1}{s+2}\right)\cdot\left(\frac{s^2+2s}{s^2+2s+10}\right) = \frac{//}{//}\cdot\frac{s\cdot(s+2)}{//}$$

$$= \frac{-1s^2}{s^2+2s+10}$$

num = -1 0
det = 1 2 10

3)

$W = D = 0 \Rightarrow$ messfehler

$$\frac{Y}{R} = \frac{-KVP}{1+KVP} = \frac{\left(\frac{-10}{s^2+2s}\right)}{\left(\frac{s^2+2s+10}{s^2+2s}\right)} = \frac{-10}{s^2+2s+10}$$

num = -10
det = 1 2 10

2) c) $E_w = w - (y+R) \qquad R=0$

$= w - y$

$E_w(s) = W(s)\,(1 - G_w(s)) = \dfrac{1 - G_w(s)}{s}$

$= \dfrac{1 - \dfrac{K}{s^2+2s+K}}{s}$

$\lim_{t\to\infty} e_w(t) = \lim_{s\to 0} s \cdot E_w(s)$

$= s \cdot \dfrac{1-G_w(s)}{s} = 1 - G_w(s)$

$\lim_{s\to 0} 1 - G_w(s) = 1 - \dfrac{K}{s^2+2s+K} = 1 - \dfrac{K}{K} = 1-1$

$\boxed{\lim_{t\to\infty} e_w(t) = 0}$

d) $y(s) = D(s) \cdot G_d(s) \qquad D(s) = \dfrac{1}{s}$

$= \dfrac{1}{s} \cdot \dfrac{-s^2}{s^2+2s+10}$

$= \dfrac{-s}{s^2+2s+10}$

$G_d(s) = \dfrac{-s^2}{s^2+2s+10}$

$\boxed{\dfrac{-e^{-t}}{3} \cdot \left(-\sin(3t) + 3\cos(3t)\right)}$

(58) $y(t) = -1 \cdot \mathcal{L}^{-1}\left[\dfrac{s}{s^2+2s+10}\right] = \dfrac{-e^{-t}}{3} \cdot \left(-\sin(3t) + 3\cos(3t)\right)$

2) e) $KVP = \frac{10}{s} \cdot \frac{1}{s} \cdot \frac{1}{s+2} = \frac{10}{s^3+2s^2}$

$$\frac{Y}{W} = \frac{KVP}{1+KVP} = \frac{\left(\frac{10}{s^3+2s^2}\right)}{1+\left(\frac{10}{s^3+2s^2}\right)}$$

$$= \frac{\left(\frac{10}{s^3+2s^2}\right)}{\left(\frac{s^3+2s^2+10}{s^3+2s^2}\right)} = \frac{10}{s^3+2s^2+10}$$

num = 10
det = 1 2 0 10