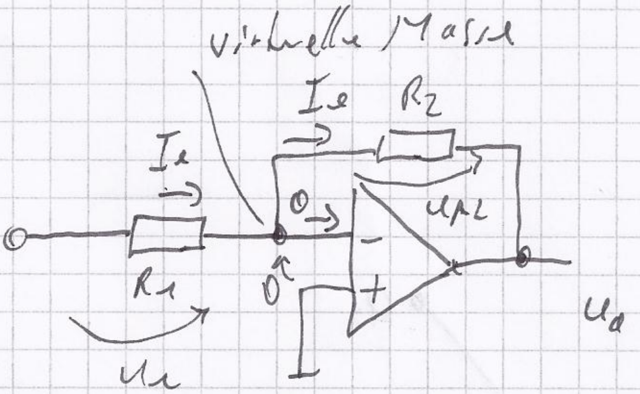
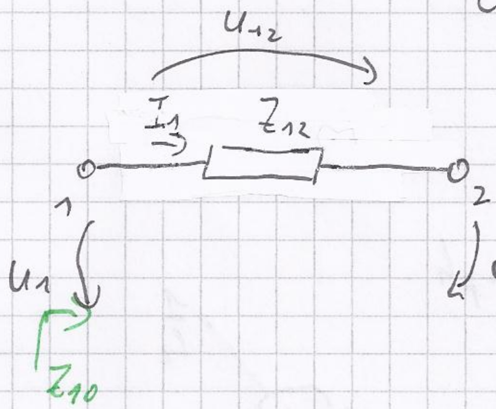
Integrierte Schaltungstechnik

(IST VL 2012)



$$I_e = \frac{U_e}{R_1} \qquad U_{R2} = U_e \frac{R_2}{R_1}$$

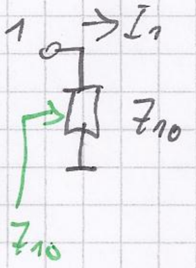
$$U_a = -U_{R2} = -U_e \frac{R_2}{R_1}$$

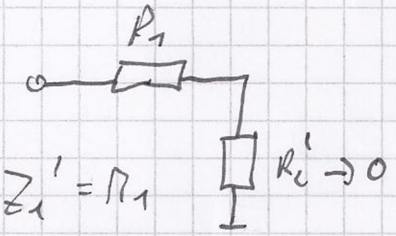


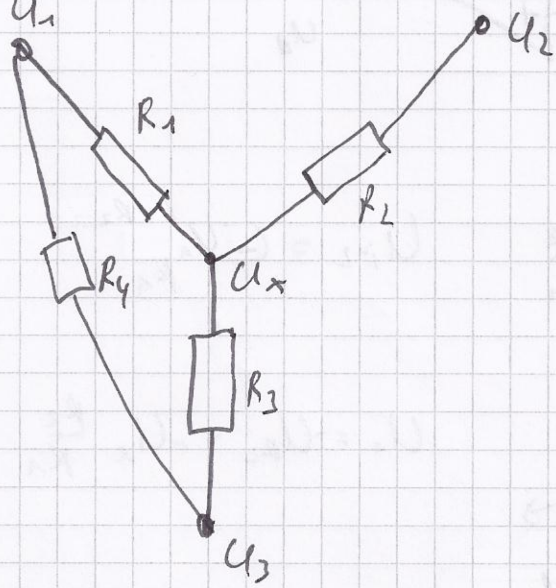
$$v_u \cdot U_1 = U_2$$

$$I_1 = \frac{U_1 - v_u U_1}{Z_{12}} = \frac{U_1}{Z_{12}}(1 - v_u)$$

$$Z_{10} = \frac{U_1}{I_1} = \frac{Z_{12}}{1 - v_u}$$

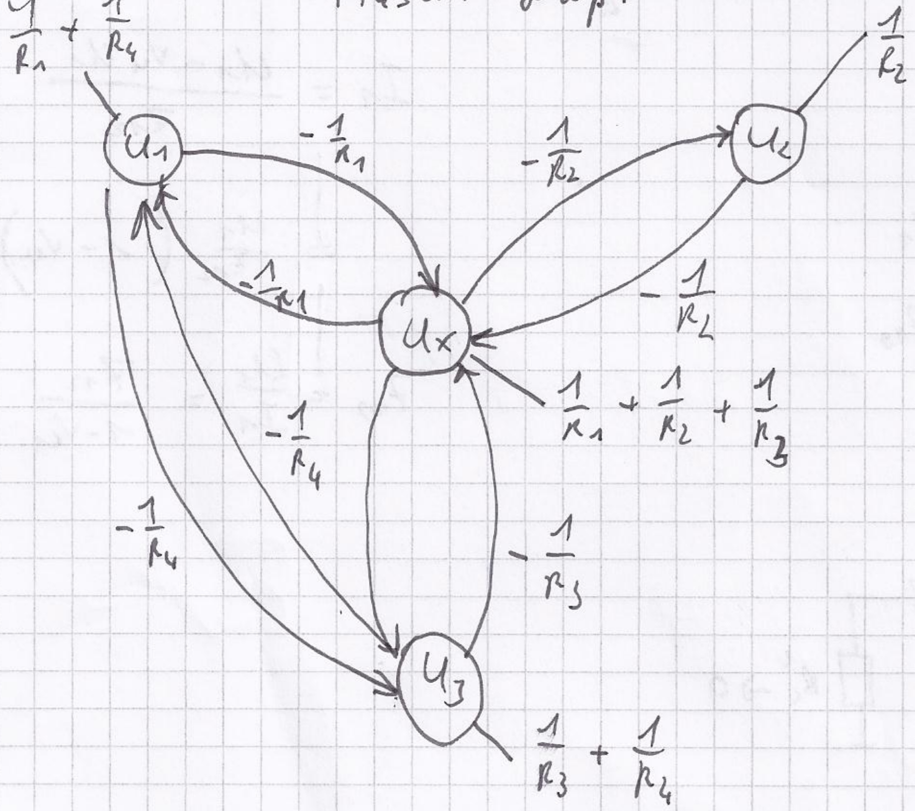


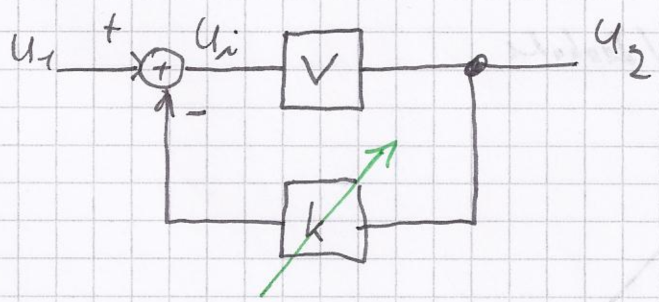


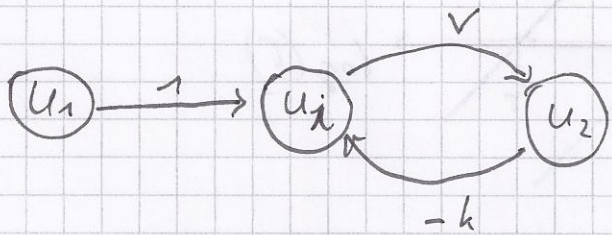

U1
U2
R1
R2
R4
Ux
R3
U3

⇓

Mason-Graph


1/R1 + 1/R4
1/R2
U1
U2
Ux
U3
-1/R1
-1/R1
-1/R2
-1/R2
-1/R4
-1/R4
-1/R3
1/R1 + 1/R2 + 1/R3
1/R3 + 1/R4





$$u_2 = u_1 \cdot v + u_2 \cdot (-k) \cdot v$$

$$u_2 (1+kv) = u_i \cdot v$$

$$v' = \frac{u_2}{u_1} = \frac{v}{1+kv} = \frac{v}{q}$$

v' → Verstärkung des rückgekoppelten System

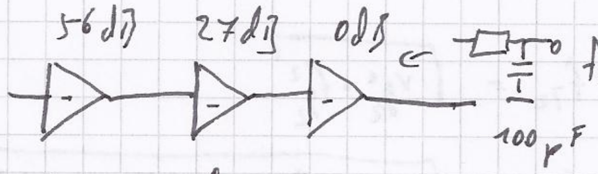
$q = 1+kv$ → Rückkopplungspfad

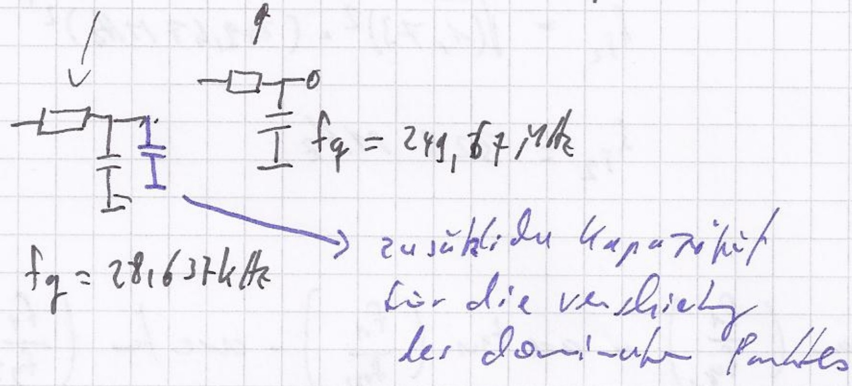
Bei $\underline{k}\,\underline{v} = -1$ geht v' gegen unendlich und das System ist nicht stabil.

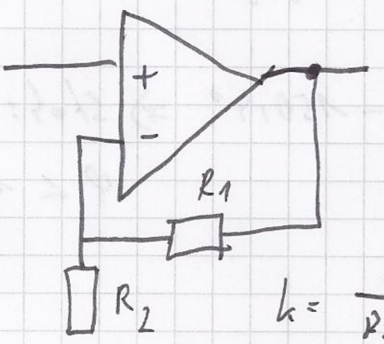
$$|\underline{k}\,\underline{v}| = 1$$

$P_{kv} = 180° + n\, 360°$ Phasenrand $\varphi_R = 180° + \varphi_{f1}$

1. Übungsaufgabe







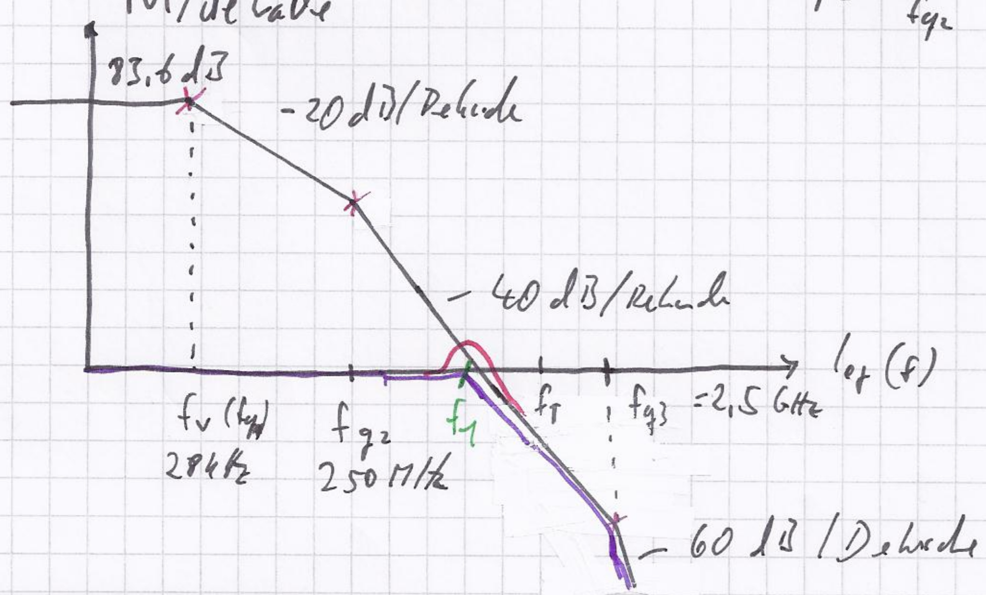
$$k = \frac{R_2}{R_2 + R_1}$$

$$\underline{V} = \frac{V_1}{1 + j\frac{f}{f_{g1}}} \cdot \frac{V_2}{1 + j\frac{f}{f_{g2}}} \cdot \frac{V_3}{1 + j\frac{f}{f_{g3}}}$$

$$V_0 = V_1 + V_2 + V_3 = 83,6\,dB = 15100$$

$$f_T = 15100 \cdot f_v = 432\,MHz$$

$$v_{g2} = \frac{f_T}{f_{g2}} = 1.73$$



Transitfrequenz 2. Ordnung

1.

$$f_{T_2}^2 = v_{g2} \cdot f_{g2}^2 \rightarrow f_{T_2} = \sqrt{v_{g_2}^2 \cdot f_{g_2}^2}$$

$$f_{T_2} = \sqrt{(1,73)^2 \cdot (249,67\,MHz)^2}$$

$$f_{T_2} = 328\ MHz$$

2.

$$\varphi = -\arctan\left(\frac{f_1}{f_{g_1}}\right) - \arctan\left(\frac{f_1}{f_{g2}}\right) - \arctan\left(\frac{f_1}{f_{g3}}\right)$$

$$\varphi \approx -90° - 52,8° - 7,6° = -150,4°$$ ⇒ stabil da $\varphi < 180°$

$$\varphi_R = 29,6° = 180° + \varphi$$

7.

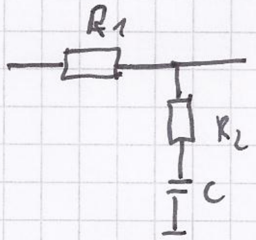
$\varphi_R = 60^\circ = 180 + \varphi$

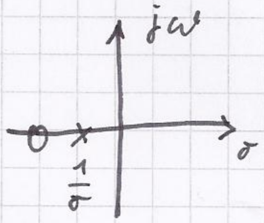
$60^\circ - 180^\circ = \varphi = -120^\circ$

für $\varphi_R = 60^\circ \rightsquigarrow f_1 \triangleq 127\ MHz$

$v' = \frac{f_T}{f_1} = 3{,}39 \approx 3{,}4$

Verlegung des dominanten Pols





$$\frac{1 + j\omega R_2 C}{1 + j\omega (R_1 + R_2) C}$$

- Polnullstellen-Kompensation
- pole-Splitting
- Miller-Kompensation