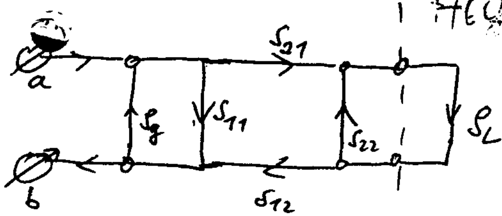
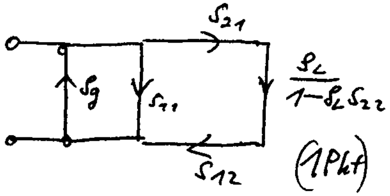
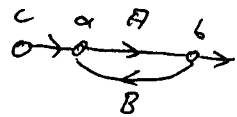
Hellwegel 3



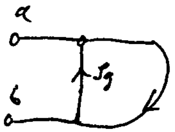
(a) Berechnen Sie ~~(b)~~ b/a, die Transmission



(1Pkt)



$$a \cdot A = b$$
$$c + b \cdot B = a$$
$$\Leftrightarrow (c + b \cdot B) \cdot A = b$$
$$\Leftrightarrow c \cdot A + b \cdot B \cdot A = b$$
$$\Leftrightarrow b = c \cdot \frac{A}{1-BA}$$



$$S_{11} + \frac{\rho_L S_{12} S_{21}}{1-\rho_L S_{22}}$$

(2Pkt)

$$\frac{S_{11} + \frac{\rho_L S_{12} S_{21}}{1-\rho_L S_{22}}}{1 - \rho_g \cdot \left(S_{11} + \frac{\rho_L S_{12} S_{21}}{1-\rho_L S_{22}}\right)}$$

$$= \frac{S_{11}(1-\rho_L S_{22}) + \rho_L S_{12} S_{21}}{1-\rho_L S_{22} - \rho_g S_{11}(1-\rho_L S_{22}) + \rho_L \rho_g S_{12} S_{21}}$$ (1Pkt)

(b) Unter der Voraussetzung, dass ρ_g ideal $= 0$ ist bestimmen Sie ρ_L abhängig von b/a! (Wenn Sie Ihrer Lösung aus (a) nicht vertrauen, dann rechnen Sie (a) nochmals ohne ρ_g)

$$b/a = S_{11} + \frac{\rho_L S_{12} S_{21}}{1-\rho_L S_{22}}$$

$$\Leftrightarrow \left(\frac{b}{a} - S_{11}\right) \cdot (1-\rho_L S_{22}) = \rho_L S_{12} S_{21}$$

$$\Leftrightarrow \frac{b}{a} - S_{11} - \rho_L S_{22}\left(\frac{b}{a} - S_{11}\right) = \rho_L S_{12} S_{21}$$

$$\Leftrightarrow \quad \frac{b}{a} - S_{11} = \rho_L \left[S_{12}S_{21} + S_{22}\left(\frac{b}{a} - S_{11}\right)\right]$$

$$\Leftrightarrow \quad \rho_L = \cancel{\frac{S_{12}S_{21}}{\frac{a}{b} - S_{11}} + S_{22}} \; \frac{\frac{b}{a} - S_{11}}{S_{12}S_{21} + S_{22}\left(\frac{b}{a} - S_{11}\right)}$$

insgesamt (2 Pkt)

(c) Bestimmen Sie die Korrekturkoeffizienten A, B, C, D in der Formel

$$\rho_L = \frac{A\frac{b}{a} + B}{C\frac{b}{a} + D}$$

1 Pkt

$$\Rightarrow A = 1; \quad B = -S_{11}; \quad C = S_{22}; \quad D = S_{12} \cdot S_{21} - S_{22}S_{11}$$

~~(d) Unter der Annahme, dass es sich bei dem Zwischengeschalteten 4-Pol um eine einfache, sehr gut an beiden Seiten angepasste Leitung handelt kann man $S_{11} = S_{22} = 0{,}1$ und $S_{21} = S_{12} = \sqrt{(1 - S_{11}^2)} = 0.995$ annehmen. Geben Sie mit diesen Werten ρ_L an~~

$$\cancel{\rho_L = \frac{a/b - 0{,}1}{0{,}1\frac{a}{b} - 0{,}8701}}$$

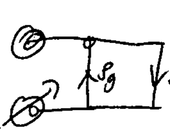
(d) Für $S_{11} = S_{22} = 0$ und $S_{12} = S_{21} = 0$ (ideale Leitung ohne Phasendrehung) gehen Sie zu (c) zurück und berechnen Sie mit $\rho_G \neq 0$ erneut ρ_L

$$\frac{b}{a} = \frac{\rho_L}{1 - \rho_L\rho_G} \quad \text{(1 Punkt)}$$

$$b/a - \rho_L \rho_g\, b/a = \rho_L$$

$$\Leftrightarrow \rho_L = \frac{b/a}{1 + \rho_g\, b/a}$$

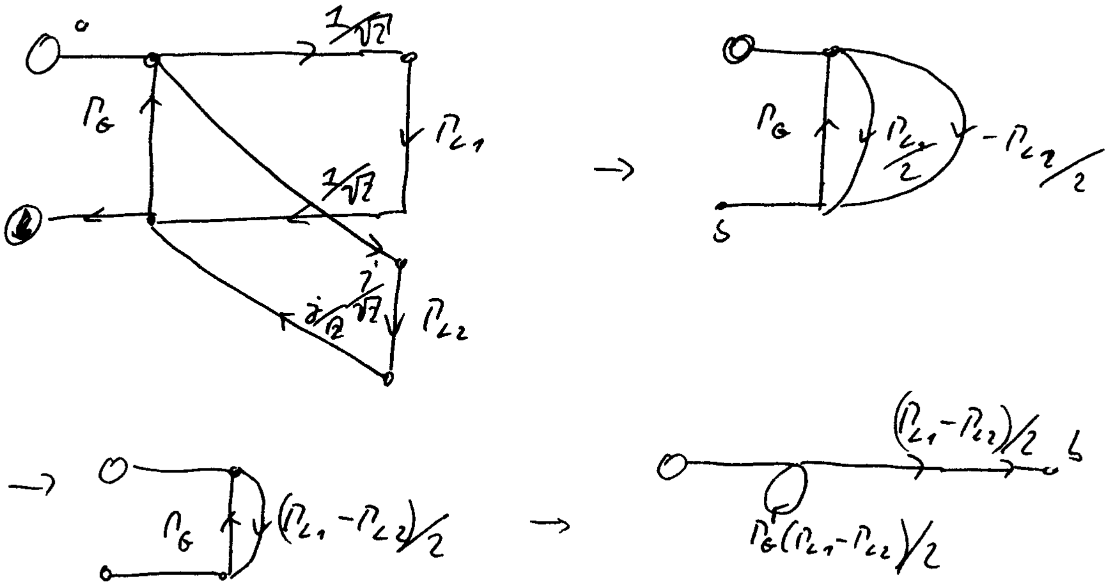
Zeichnen Sie zuerst den vereinfachten Signalflussgraphen



(1 Punkt)

3) Signalflussgraf

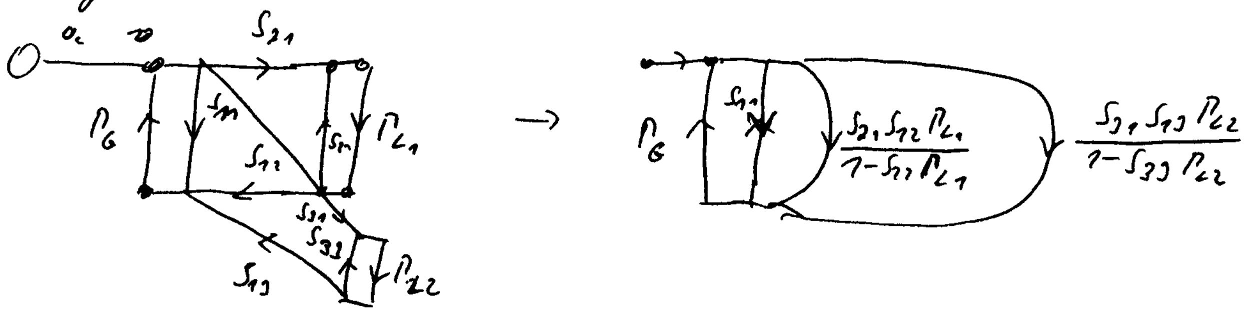
a)



$$\frac{b}{a} = \frac{\Gamma_{L1} - \Gamma_{L2}}{1-\Gamma_G(\Gamma_{L1}-\Gamma_{L2})/2} \cdot \frac{1}{2}$$ (1)

b) Analog jedoch dann $\frac{b}{a} = \frac{(\Gamma_{L1}+\Gamma_{L2})}{1-\Gamma_G(\Gamma_{L1}+\Gamma_{L2})/2} \cdot \frac{1}{2}$ (1)

c) Allgemein:



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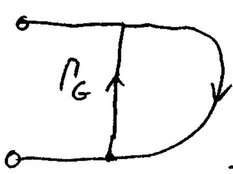


$$S_{11} + \frac{S_{21}S_{12}\Gamma_{L1}}{1-S_{22}\Gamma_{L1}} + \frac{S_{31}S_{13}\Gamma_{L2}}{1-S_{33}\Gamma_{L2}} = \left(S_{11}(1-S_{22}\Gamma_G)\cdot(1-S_{33}\Gamma_G) + S_{21}S_{12}\Gamma_{L1} + S_{31}S_{13}\Gamma_{L2}\right) \cdot \frac{1}{(1-S_{22}\Gamma_{L1})(1-S_{33}\Gamma_{L2})}$$

$= A$

$$\frac{b}{a} = \frac{A}{1-A\Gamma_G} = \cancel{S_{11}(1-S_{22}\Gamma_L} \ldots$$

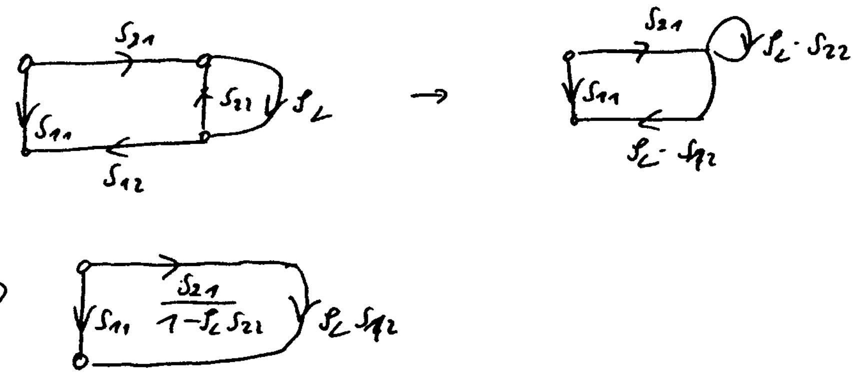
(3)

$$\frac{S_{11}(1-S_{22}\Gamma_{L1})(1-S_{33}\Gamma_{L2}) + S_{21}S_{12}\Gamma_{L1} + S_{31}S_{13}\Gamma_{L2}}{(1-S_{22}\Gamma_{L1})(1-S_{33}\Gamma_{L2}) - S_{11}(1-S_{22}\Gamma_{L1})(1-S_{33}\Gamma_{L2}) - S_{12}S_{21}\Gamma_{L1} - S_{31}S_{13}\Gamma_{L2}}$$

d) Variant a, da hier nur die Differenz der Reflexionen der beiden Stufen auftritt, die geringer ist als die Summen, wenn die beiden Verstärkerstufen weitestgehend identisch sind. (1)

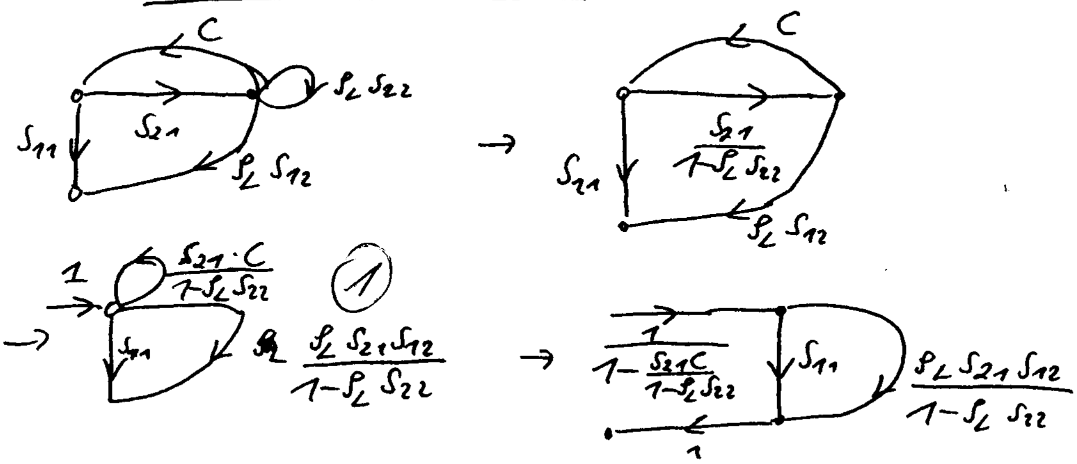
e)

a)



$\rightarrow \quad \rho_E = S_{11} + \dfrac{\rho_L \cdot S_{12} S_{21}}{1-\rho_L S_{22}}$ (1)

b)



$$\rho_E = \frac{1}{1-\frac{S_{21}C}{1-\rho_L S_{22}}} \cdot \left(S_{11} + \frac{\rho_L S_{21} S_{12}}{1-\rho_L S_{22}}\right)$$ (1)

$$= \frac{S_{11} - \rho_L S_{11} S_{22} + \rho_L S_{21} S_{12}}{1-\rho_L S_{22} - S_{21} C}$$ (2)

c) Es muss $\rho_L S_{22} = -S_{21} C \Leftrightarrow C = -\dfrac{\rho_L S_{22}}{S_{21}}$ (1)

da $|\rho_L| < 1$; $|S_{22}| < 1$ und $|S_{21}| > 1$ gilt (in der Regel) folgt dann auch $|C| < 1$, womit C mit passiven Elementen realisierbar ist (1) (2)

d) Abgelesen:

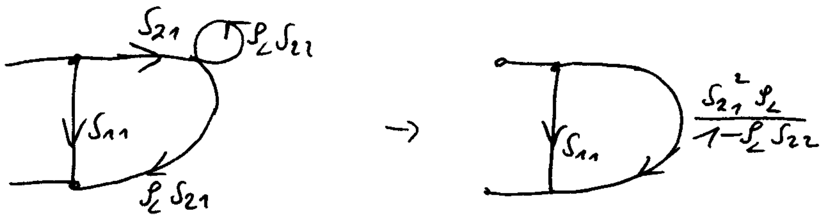
$$b_E = K \cdot a_A + K^2 \rho_A a_s + K^3 \rho_E \rho_s \rho_A \cdot b_E$$ (1)

$$\Leftrightarrow b_E = \frac{K a_A + K^2 \rho_A a_s}{1 - K^3 \rho_E \rho_s \rho_A}$$ (1) (2)

e) Mit $\rho_A = 0$ sind wir diese Koppelprobleme & auch noch das Schleifenproblem los! (1)

Nr. 5

a)



$$\frac{b}{a} = S_{11} + \frac{S_{21}^2 \rho_L}{1-\rho_L S_{22}}$$

b) $$\frac{b}{a}\left(1-\rho_L S_{22}\right) = S_{11} + S_{21}^2 \rho_L - \rho_L \cdot S_{11} S_{22}$$

$$\Leftrightarrow \frac{b}{a} - S_{11} = \rho_L \cdot \left(S_{21}^2 + \frac{b}{a} S_{22} - S_{11} S_{22}\right)$$

$$\Leftrightarrow \rho_L = \frac{\frac{b}{a} - S_{11}}{S_{21}^2 + \frac{b}{a} S_{22} - S_{11}S_{22}} = \frac{0{,}5-0{,}2}{0{,}64+0{,}5\cdot 0{,}2-0{,}04} = \frac{0{,}3}{0{,}70} = \cancel{0{,}4054} \quad \frac{3}{7}$$

c) $\rho_L = 0$: $\cancel{b}$ $0{,}1 = S_{11}$ (1)

$\rho_L = -1$: $-\frac{7}{11} = S_{11} - \frac{S_{21}^2}{1+S_{22}}$ (2)

$\rho_L = 1$: $1 = S_{11} + \frac{S_{21}^2}{1-S_{22}}$ (3)

d) $\underline{\underline{S_{11} = 0{,}1}}$

e) aus $\rho_L = 1$: $1 = S_{11} + S_{12}^2$

$\Leftrightarrow S_{12}^2 = 0{,}9$; $S_{12} = \underline{\underline{0{,}9487}}$

f) (2) : $\cancel{\frac{7}{11}\cdot(1+S_{22}) - S_{11}} = -S_{21}^2 = \left(-\frac{7}{11} - S_{11}\right)\cdot(1+S_{22})$

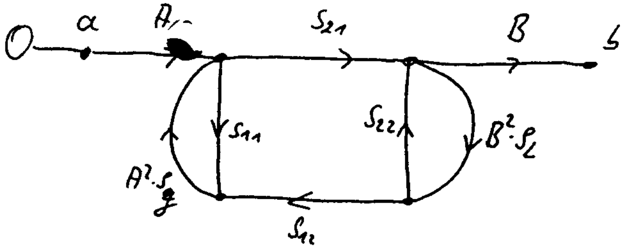
(3) $\cancel{(1-S_{22}) - S_{11}} = S_{21}^2 = (1-S_{11})(1-S_{22})$

Summe der Gleichungen: $0 = -\frac{7}{11} - S_{11} + 1 - S_{11} + S_{22}\cdot\left(-\frac{7}{11} - S_{11} - 1 + S_{11}\right)$

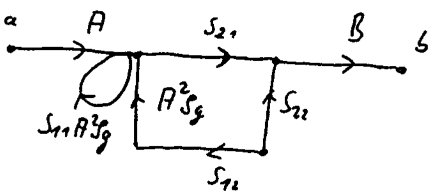
$$\Leftrightarrow \frac{2S_{11} - \frac{4}{11}}{-\frac{18}{11}} = \frac{22\,S_{11} - 4}{-18} = S_{22} = \underline{\underline{0{,}1}}$$

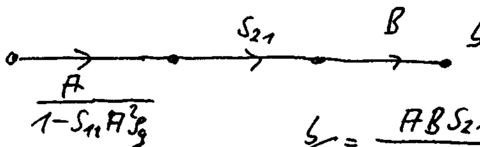
$$\Rightarrow S_{21}^2 = (1-S_{11})\cdot(1-S_{22}) = 0{,}81 \Rightarrow \underline{\underline{S_{21} = 0.9}}$$

3)



mit $\Gamma_L = 0$:

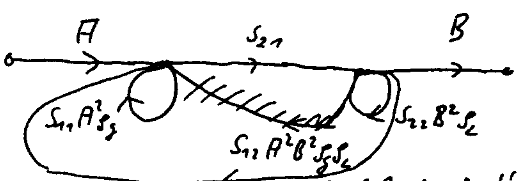




$$\frac{b}{a} = \frac{A B S_{21}}{1 - S_{11} A^2 \Gamma_g}$$

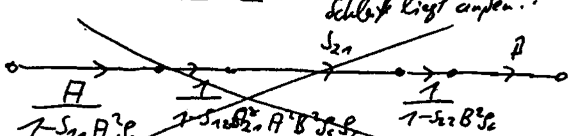
(2)

b) $\Gamma_L \neq 0$



(2)

Schleife liegt anders!!



$$\cancel{\frac{b}{a} = \frac{A S_{21} B}{(1-S_{11}A^2\Gamma_g)(1-S_{12}S_{21}A^2B^2\Gamma_g\Gamma_L)(1-S_{22}B^2\Gamma_L)}}$$

$$\frac{b}{a} = \frac{A S_{21} B}{(1-S_{11}A^2\Gamma_g)\cdot(1-S_{22}B^2\Gamma_L) - A^2B^2S_{12}\Gamma_g\Gamma_L}$$

3c) $$S_{21} = \frac{b/a \cdot (1 - S_{11} A^2 \rho_g)}{AB} \qquad 1$$

d) $$S_{21} = b/a \cdot (1 - S_{11} \rho_g)$$

S_{11} passiv: $S_{11} = -1 \dots 1$

z. $\rho_g = -10\,dB \mathrel{\hat{=}} 0{,}316 \Rightarrow \underline{\underline{S_{21} = \frac{b}{a} \cdot (0{,}684 \dots 1{,}316)}}$

$\rho_g = -20\,dB \mathrel{\hat{=}} 0{,}1 \Rightarrow \underline{\underline{S_{21} = \frac{b}{a} \cdot (0{,}9 \dots 1{,}1)}} \qquad 2$