Tutorial 3

Agenda

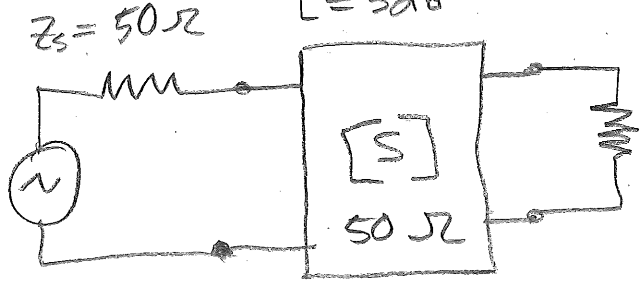
* Stability
* Unilateral design ($S_{12} \approx 0$)
* Bilateral design ($S_{12} ! \approx 0$)

Glöm ej

- Räkna uppgifterna själva → see att det blir rätt
- Finns mängder av gamla tentatal

P. 6,3

Dämpare
$L = 3\,dB$



$Z_L = 50\,\Omega,\ 25\,\Omega$

$G_T = G_A = G_P = ?$

Dämpare = passiv reciprok device

inga reflektioner

$$[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} = \begin{bmatrix} 0 & 0{,}708 \\ 0{,}708 & 0 \end{bmatrix}$$

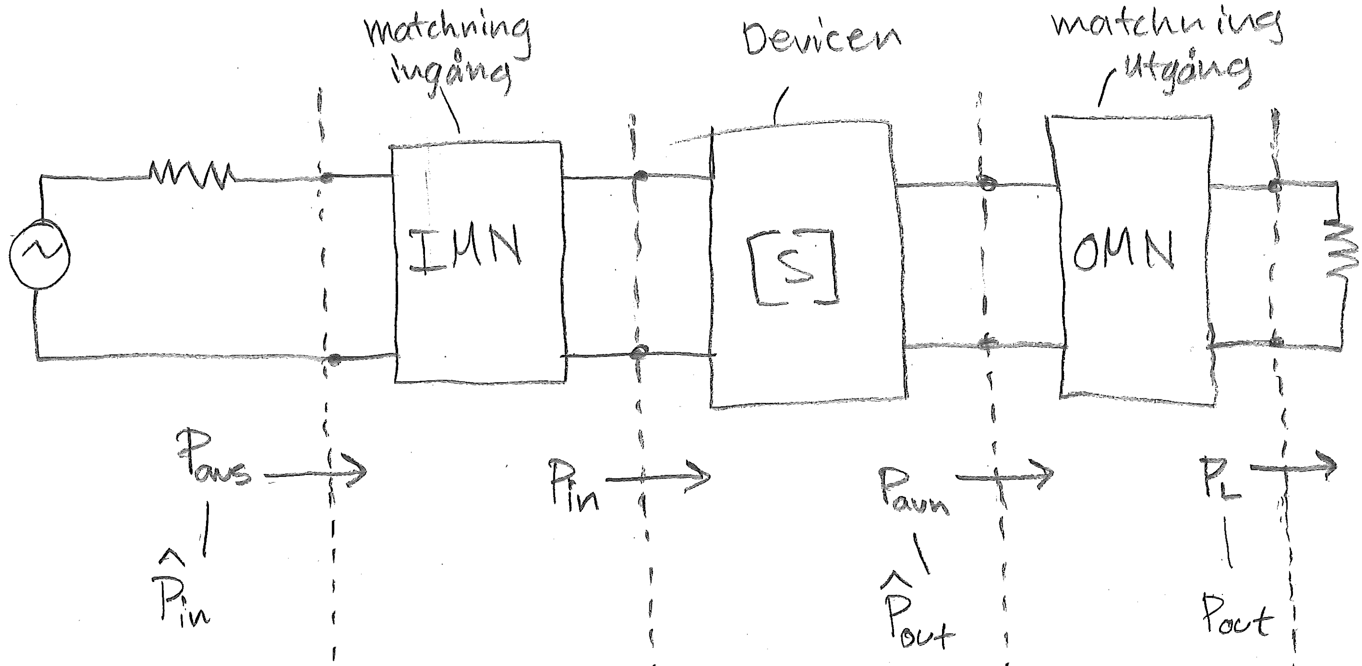
$$G = -3\,dB = |S_{21}|_{dB} = |S_{12}|_{dB} = 20\log|S_{21}|$$

samma transmission i båda riktningarna

$$\Rightarrow |S_{21}| = 10^{-\frac{3}{20}} =$$

$$= 0{,}708$$

$$\Rightarrow |S_{12}| = 0{,}708$$



$$G_T = \frac{P_L}{P_{avs}} = \frac{P_{out}}{\hat{P}_{in}}$$ beror på IMN, OMN

$$G_P = \frac{P_L}{P_{in}} = \frac{P_{out}}{P_{in}}$$ beror på OMN

$$G_A = \frac{P_{avn}}{P_{avs}} = \frac{\hat{P}_{out}}{\hat{P}_{in}}$$ beror på IMN

P 6,16

$$G_T = \frac{|S_{21}|^2(1-|\Gamma_s|^2)(1-|\Gamma_L|^2)}{|1-\Gamma_s\Gamma_{in}|^2|1-S_{22}\Gamma_L|^2}$$

$\Gamma_L = ?$ $\Gamma_s = ?$

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = 0 = \Gamma_s$$

Z_L: 50, Z_0: 50

$\Gamma_s = \Gamma_L = 0$

Γ_{in}?

$$\Rightarrow G_T = |S_{21}|^2 = 0{,}708^2 = -3\text{ dB}$$

$$G_P = \frac{|S_{21}|^2(1-|\Gamma_L|^2)}{(1-|\Gamma_{in}|^2)|1-S_{22}\Gamma_L|^2}$$

$$\Gamma_{in} = \underbrace{S_{11}}_{=0} + \frac{S_{12}S_{21}\overbrace{\Gamma_L}^{=0}}{1-S_{22}\underbrace{\Gamma_L}_{=0}} = 0$$

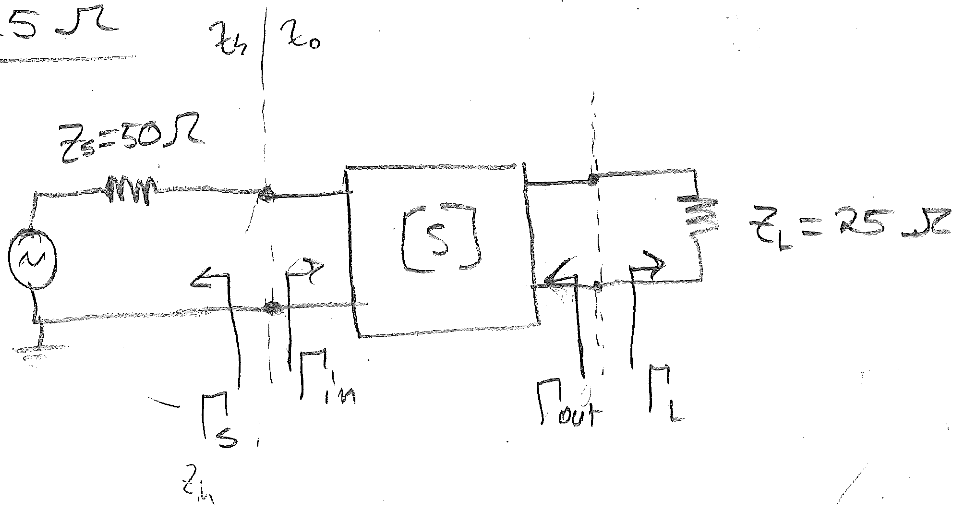
P 6,11

$$\Rightarrow G_P = |S_{21}|^2 = -3\text{ dB}$$

$$G_A = \frac{|S_{21}|^2 (1-|\Gamma_s|^2)}{|1-S_{11}\Gamma_s|^2 (1-|\Gamma_{out}|^2)}$$ — P. 6,15 $\qquad \Gamma_{out} = \frac{\overset{50}{Z_{out}} - \overset{50}{Z_L}}{Z_{out}+Z_L} = 0$

$$\Rightarrow \quad G_A = |S_{21}|^2 = -3 \text{ dB}$$

$\underline{Z_L = 25\ \Omega}$



$\underline{G_T}$: $\quad \Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{25-50}{25+50}$

$$\Gamma_S = \frac{Z_S - Z_0}{Z_S + Z_0} = 0$$

$\Rightarrow \quad \Gamma_L = -1/3 \qquad \Gamma_{in} = S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1 - S_{22}\Gamma_L} =$

$$= \underbrace{S_{11}}_{}\overset{=0}{} + S_{12}S_{21}\Gamma_L = 0{,}708^2 \cdot -1/3 = -1/6$$

$G_T = \ldots = 0{,}4456$ (beror på Z_L, Z_S)

$G_A = \ldots = 0{,}501 = -3$ dB (beror ej på Z_L)

$G_P = \ldots = 0{,}458$ (beror på Z_L)

6,4 $f = 1,8$ GHz

$$S = \begin{bmatrix} 0,34\angle{-170°} & 0,06\angle{70°} \\ 4,3\angle{80°} & 0,45\angle{-25°} \end{bmatrix}$$

$K = ?$ $\mu = ?$ $\longrightarrow$ stability circles

K-Δ test P. 6,31-32

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}S_{21}|} = \ldots = 1,35 > 1 \text{ ok}$$

$\Rightarrow$ Stabil

$$|\Delta| = |S_{11}S_{22} - S_{12}S_{21}| = 0,1171 < 1$$

μ-test P 6,33

$$\mu = \frac{1 - |S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{12}S_{21}|} = \ldots = \underline{1,193} > 1 \Rightarrow \text{stable}$$

6,9 Design max gain amplifier

$f = 5$ GHz Transistor: GaAs FET

$Z_0 = 50\,\Omega$

$$[S] = \begin{bmatrix} 0{,}65\angle -140^\circ & 0{,}04\angle 60^\circ \\ 2{,}4\angle 50^\circ & 0{,}70\angle -65^\circ \end{bmatrix}$$

For matching: use Open circuit for IMN, OMN

1. Är transistorn stabil?

K-Δ p 6,31-32

$$K = \frac{1-|S_{11}|^2-|S_{22}|^2+|\Delta|^2}{2|S_{12}S_{21}|} = \ldots = 1{,}2603 > 1$$

$$|\Delta| = |S_{11}S_{22}-S_{12}S_{21}| = \ldots = 0{,}393 < 1$$

$\Rightarrow$ stabil

2. Kan vi tillämpa unilateral design?
$\rightarrow$ annars bilateral

* Avgörs av S_{12}, kolla U = "Ett mått på hur unilateral våran device är"

our rule of thumb

$$U = \frac{|S_{11}||S_{12}||S_{21}||S_{22}|}{(1-|S_{11}|^2)(1-|S_{22}|^2)} = \ldots = 0{,}1483 > 0{,}05$$

$$\frac{1}{(1+U)^2} < \frac{G_T}{G_{TU}} < \frac{1}{(1-U)^2}$$

$$\frac{1}{(1-U)^2} = 1{,}38 = 1{,}394 \text{ dB}$$

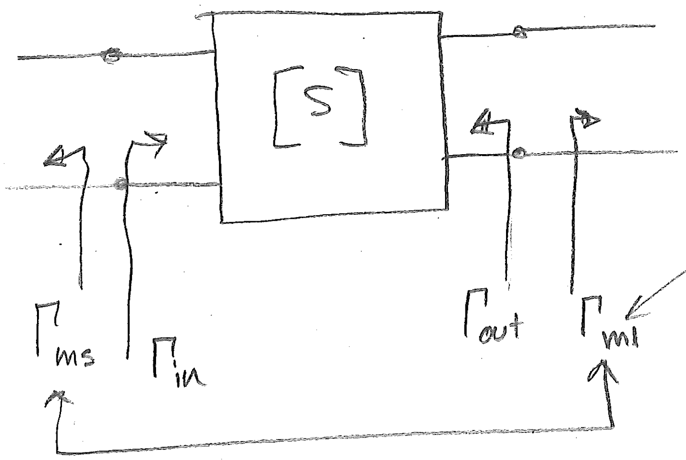
för stort fel $\longrightarrow$

$$-1{,}201 \text{ dB} < G_{T,dB} - G_{TU,dB} < 1{,}394 \text{ dB}$$

3. Tillämpa unilateral eller bilateral design

nårat fall

- Vi har färdiga formler för max gain för bilateral design



betecktans ofta med m vid bilateral simultan konjugatmatchning

Förmlerna bestämmer konjugatreflektionskoefficienterna

d.v.s. $\Gamma_{ms} = \Gamma_{in}^*$ $\qquad \Gamma_{ml} = \Gamma_{out}^*$

$(Z_s = Z_{in}^*)$

Pozar 6,43 ... 44

$$\Gamma_{ms} = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1}$$

$$\Gamma_{ml} = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2}$$

$B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta^2|$

$B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta^2|$

$\Delta = S_{11}S_{22} - S_{12}S_{21}$

$C_1 = S_{11} - \Delta S_{22}^*$

$C_2 = S_{22} - \Delta S_{11}^*$

$\Rightarrow \Gamma_{ml} = \ldots = 0{,}85\angle 71^\circ \qquad \Gamma_{ms} = \ldots = 0{,}83\angle 147^\circ$

Nu kan vi beräkna gainet (anta transducer gain G_T om inget annat anges)

P. 6,16

$G_S = 3{,}14$ $\quad G_0$ 5,76 $\quad G_L$ 1,64 $\quad$ Kolla i boken för unilaterala fallet

$$G_T = \underbrace{\frac{(1-|\Gamma_s|^2)}{|1-\Gamma_s\Gamma_{in}|^2}}_{G_S}\underbrace{|S_{21}|^2}_{G_0}\underbrace{\frac{(1-|\Gamma_L|^2)}{|1-S_{22}\Gamma_L|^2}}_{G_L}$$

$\Gamma_s = \Gamma_{ms}$

$\Gamma_L = \Gamma_{ml}$

$\Gamma_{in} = \Gamma_{ms}^*$

P. 6,22a

$$\Gamma_{in} = S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1-S_{22}\Gamma_L} = \ldots = 0{,}83\angle{-147} = \Gamma_{ms}^* \text{ ok!}$$

$$\Rightarrow \quad G_T = \ldots = 29{,}6 = 14{,}7 \text{ dB}$$

4. Matchningsnät

skapa $\Gamma_{ms} = 0{,}83\angle 147°$

1. Markera Γ_{ms}

2. Dra Γ_{ms} cirkeln så att du skär $g=1$ cirkeln

3. Lägg till stubben så att du hamnar på Γ_{ms} cirkeln. Bestäm l_s

4. Rotera med transmissionsledning till Γ_{ms}. Bestäm längden på ledningen d_s

Γ_{ms}

$d_s = 0{,}5\lambda - 0{,}453\lambda + 0{,}046\lambda = \underline{0{,}093\lambda}$

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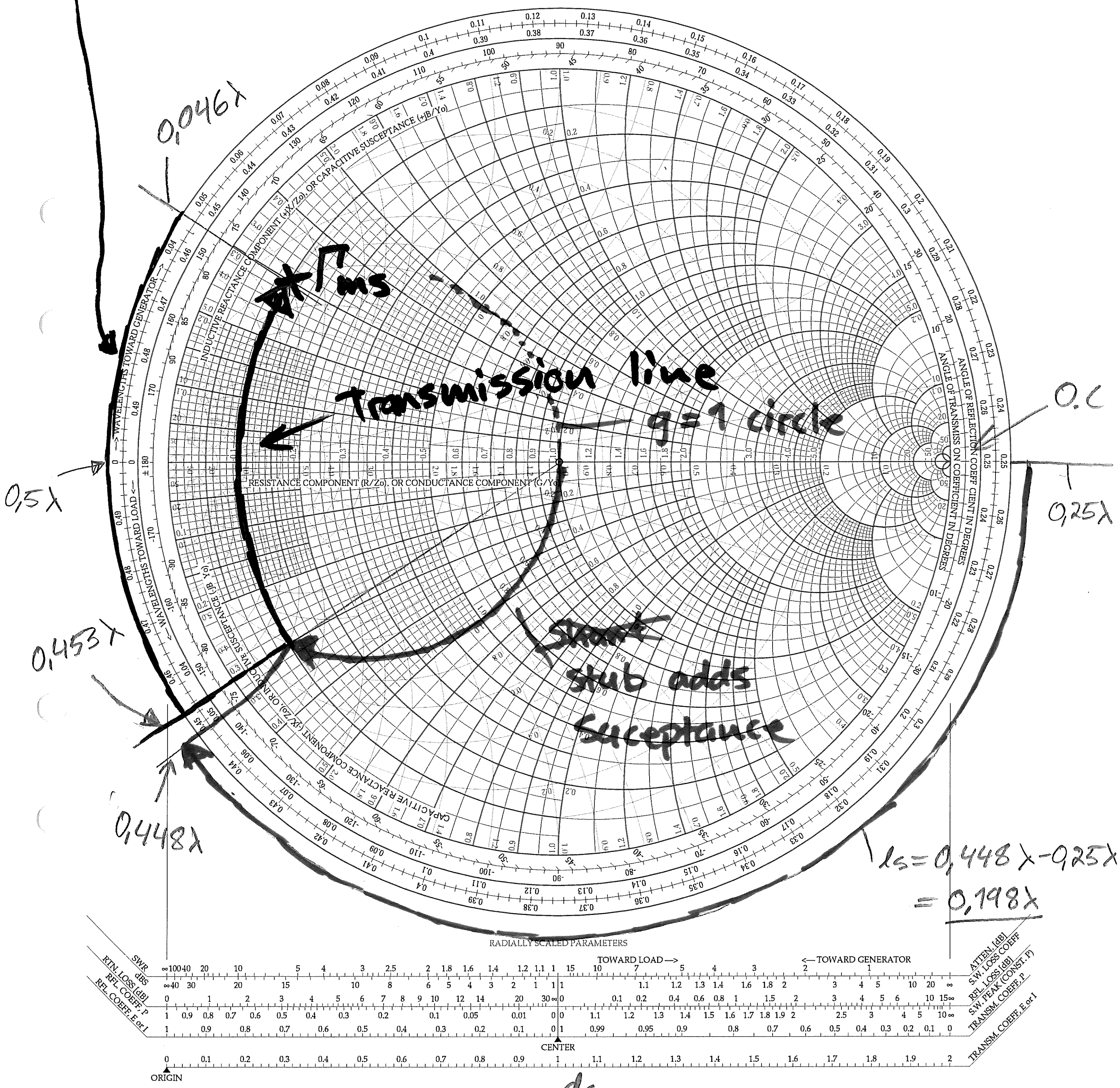
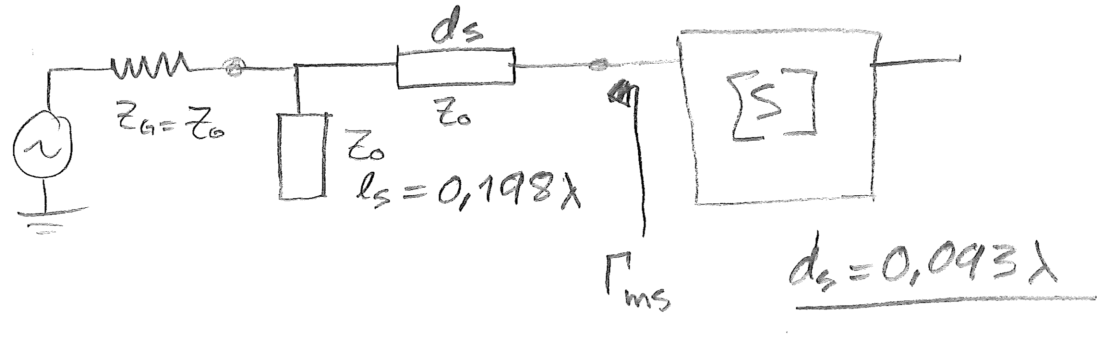
		DATE
SMITH CHART FORM ZY-01-N	Microwave Circuit Design - EE523 - Fall 2000	

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES





Γ_{m1}

$d_l = 0{,}152\lambda - 0{,}044\lambda = \underline{0{,}108\lambda}$

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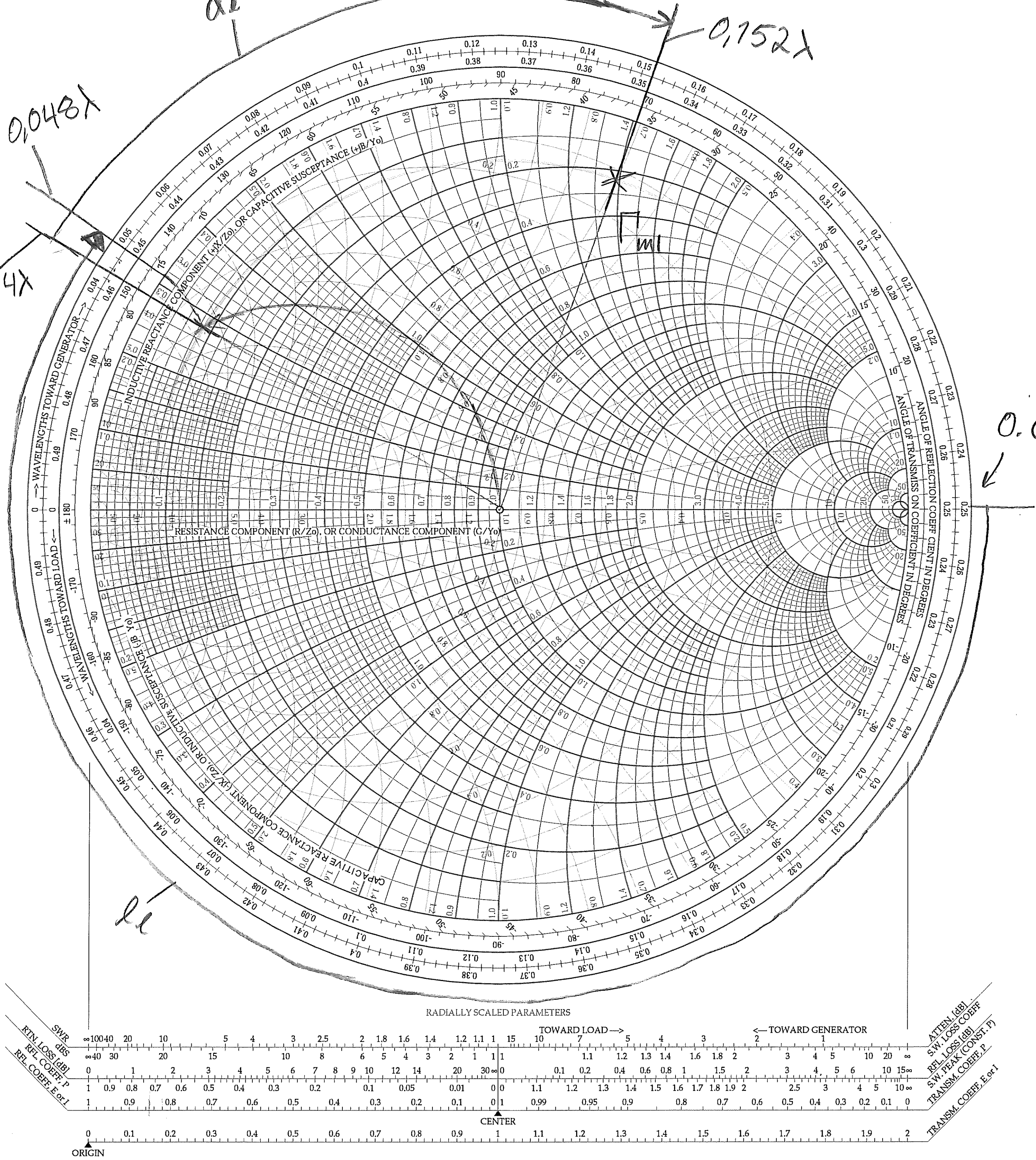
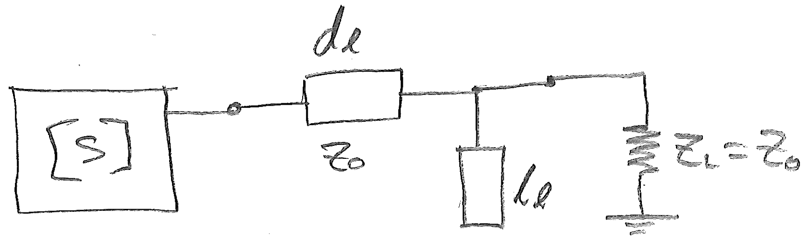
NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES



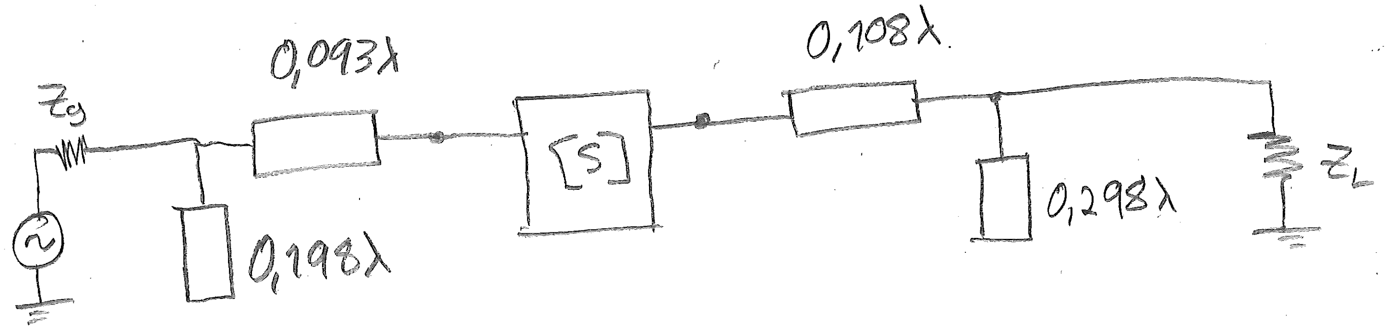
$l_l = 0{,}25\lambda + 0{,}048\lambda = \underline{0{,}298\lambda}$

$\Gamma_{ml} = 0{,}85\angle 71^\circ$ $\quad$ $d_\ell = 0{,}108\lambda$

samma procedur $\Rightarrow$ $l_\ell = 0{,}298\lambda$



vi har nu hela designen:



Tenta 170411 3

Från upg 2 bestämde vi: $\Gamma_s = 0{,}9\angle -90^\circ$

$\Gamma_L = 0{,}5\angle -180^\circ$

För transistorn: $[S] = \begin{bmatrix} 0{,}8\angle 90^\circ & 0{,}01\angle 90^\circ \\ 5\angle 0^\circ & 0{,}9\angle 0^\circ \end{bmatrix}$

Finns det något problem?

$\rightarrow$ Kolla stabilitet $\quad$ P. 6,31 (K-Δ, rollets)

P 6,33

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2|S_{12}S_{21}|} = \ldots < 1 \quad \ldots \quad \mu = \ldots = 0{,}87 < 1$$

$$|\Delta| = |S_{11}S_{22} - S_{12}S_{21}| =$$

$\therefore$ pot. instabil

Rita stabilitetcirklar på ingång och utgång

P. 6,28–29

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^*}{|S_{22}|^2 - |\Delta|^2} = \ldots = 1{,}01$$

$$R_L = \left| \frac{S_{12} S_{21}}{|S_{22}|^2 - |\Delta|^2} \right| = \ldots = 0{,}14$$

Rita i S.D

$$C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2} = \ldots = 1{,}03\angle{-90^\circ}$$

$$R_S = \left| \frac{S_{12} S_{21}}{|S_{11}|^2 - |\Delta|^2} \right| = \ldots = 0{,}26$$

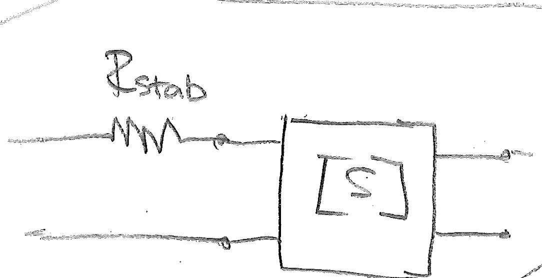
- $S_{11} < 1 \Rightarrow$ cirklarnas område = instabilt
- $\Gamma_S = 0{,}9\angle{-90^\circ}$ ligger i instabilt område!

b)

- Stabilisera med serieresistans på ingång

$\Gamma = 0{,}3 \Rightarrow R_{stab} = \Gamma \cdot Z_0 = 0{,}3 \cdot 50 = \underline{15\,\Omega}$

viktigt! labben etc



P. 6,46

$$G_{T\max} = \underbrace{\frac{|S_{21}|}{|S_{12}|}}_{G_{msg}} \overbrace{\left(K - \sqrt{K^2 - 1}\right)} = \frac{|S_{21}|}{|S_{12}|} = \frac{5}{0{,}01} = \underline{27\text{ dB}}$$

då K=1

blir mindre då K ↗ alltså överstabilisering reducerar gain. Max gain då K=1 (precis stabil)

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