Tutorial 4

Agenda

- 2-3 uppgifter
  → Bruscirklar, gaincirklar
- Egenräkning
- Frågor projektet, info
- Nästa vecka laddar jag upp tutorials
- ~~[Ta upp simultan konjugatgreffjen (slutet)]~~

P. ex 6.4 räkna 6.11 själva

* Ska jag rekommendera fler uppgifter?

- Designa förstärkare med $G_T = 11$ dB @ $f = 4$ GHz
- Plotta $G_s = 2$ dB, 3 dB och $G_L = 0$ dB, 1 dB
- Beräkna RL vid 4 GHz

Transistorn FET, $Z_0 = 50\Omega$

f	S_{11}	S_{12}	S_{21}	S_{22}
3	$0{,}8\angle{-90°}$	$2{,}8\angle{100°}$	0	$0{,}66\angle{-50°}$
→ 4	$0{,}75\angle{-120°}$	$2{,}5\angle{80°}$	0	$0{,}6\angle{-70°}$
5	—	—	—	—

P. 6.49

Vad betyder detta? Svar: Unilateral $U = 0$ ...

Notera Pozar hanterar bara gaincirklar för ingång och utgång, G_s, G_L för unilaterala transistorer

Transducer gain definitionen

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

Vi har

$$\Gamma_{in} = S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1-S_{22}\Gamma_L} = \left\{\begin{array}{c}\text{unilateral} \\ S_{12}\approx 0\end{array}\right\} = S_{11}$$

$$\Gamma_{out} = S_{22} + \frac{S_{12}S_{21}\Gamma_S}{1-S_{11}\Gamma_S} = \left\{\begin{array}{c} \\ \end{array}\right\} = S_{22}$$

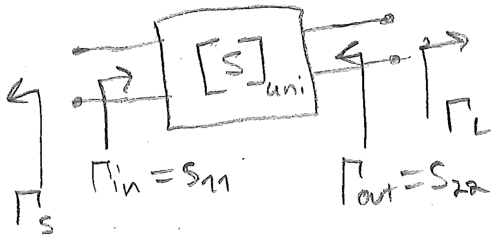
unilateral

$$\Rightarrow \quad G_T \overset{\swarrow}{=} \frac{(1-|\Gamma_S|^2)}{|1-S_{11}\Gamma_S|^2}|S_{21}|^2\frac{(1-|\Gamma_L|^2)}{|1-S_{22}\Gamma_L|^2}$$

P 6,20a-c

konjugat matchning är nu $\Gamma_L = S_{22}^*$

$\Gamma_S = S_{11}^*$



G_T blir nu $G_{TU max}$ sätt i P. 20 a-c

$$\Rightarrow \quad G_{TU,max} = \underbrace{\frac{1}{1-|S_{11}|^2}}_{G_{S max}} \underbrace{|S_{21}|^2}_{G_0} \underbrace{\frac{1}{1-|S_{22}|^2}}_{G_{L,max}} \quad \leftarrow \text{P 6,50 a-b}$$

* Undersök $G_{TU,max}$ ← alltid bra att kolla hur mycket vi kan få "kolla spelrummet"

$G_{S,max} = 2{,}29 = 3{,}6$ dB $\quad G_0 = |S_{21}|^2 = 6{,}25 = 8$ dB

$G_{L,max} = 1{,}56 = 1{,}9$ dB

$G_{TU,max} = 3{,}6\text{ dB} + 1{,}9\text{ dB} + 8\text{ dB} = 13{,}5\text{ dB}$

Vi ska ha 11 dB, introducera mismatch på ingång och utgång (gå ifrån S_{11}^*, S_{22}^*) för att sänka gainet.

- Vi ritar gaincirkeln för 2 dB från ingångsnätet
- Vi ritar gaincirkeln för 1 dB från utgångsnätet
- Transistorn ger 8 dB, totalt för vi då

$2 + 8 + 1 = 11\text{ dB}$

valda gaincirkel-värdet (2 dB)

ingången, gaincirk~~lar~~el 2 dB

P. 6,54a

$$C_S = \frac{g_S S_{11}^*}{1-(1-g_S)|S_{11}|^2}$$

$$g_S = \frac{G_S}{G_{S,max}} \quad \text{P. 6,51a}$$

$$G_{S,max} = \frac{1}{1-|S_{11}|^2}$$

$$R_S = \frac{\sqrt{1-g_S}\,(1-|S_{11}|^2)}{1-(1-g_S)|S_{11}|^2}$$

$g_S = 0{,}691$

$C_S = 0{,}627\angle 120°$

$R_S = 0{,}294$

utgången, gaincirkel, 1 dB

P 6,55a-b

P. 6,51b

1 dB

$$C_L = \frac{g_L S_{22}^*}{1-(1-g_L)|S_{22}|^2} = \ldots = 0{,}520\angle 70°$$

$$g_L = \frac{G_L}{G_{L\,max}} = 0{,}806$$

$$R_L = \frac{\sqrt{1-g_L}\,(1-|S_{22}|^2)}{1-(1-g_L)|S_{22}|^2} = \dots = 0{,}303$$

Vi har:

$G_S = 2\,dB$, $C_S = 0{,}627\angle 120°$ $R_S = 0{,}294$ $g_S = 0{,}697$

$G_L = 1\,dB$, $C_L = 0{,}520\angle 70°$ $R_L = 0{,}303$ $g_L = 0{,}806$

* Rita i SD

- S_{11}^* S_{22}^* (Γ_S, Γ_L för högsta gain)

  $S_{11}^* = 0{,}75\angle 120°$ $S_{22}^* = 0{,}6\angle 70°$

- Cirklarna

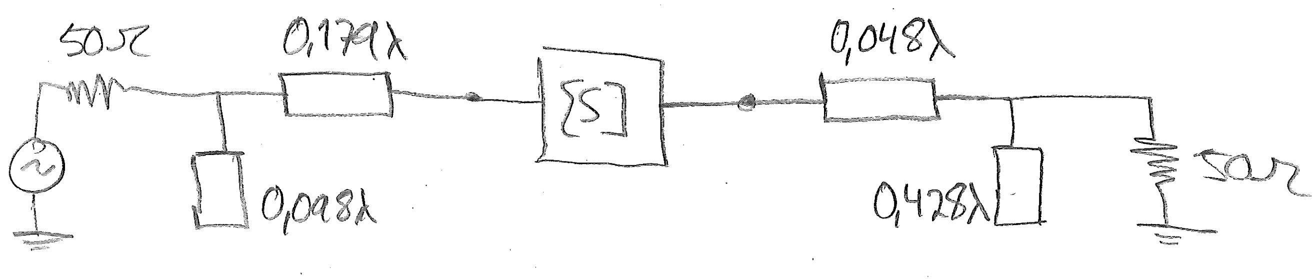
- Välj Γ_S på $G_S = 2\,dB$ cirkeln

  $\Rightarrow \Gamma_S = 0{,}33\angle 120°$

- Välj Γ_L på $G_L = 1\,dB$ cirkeln

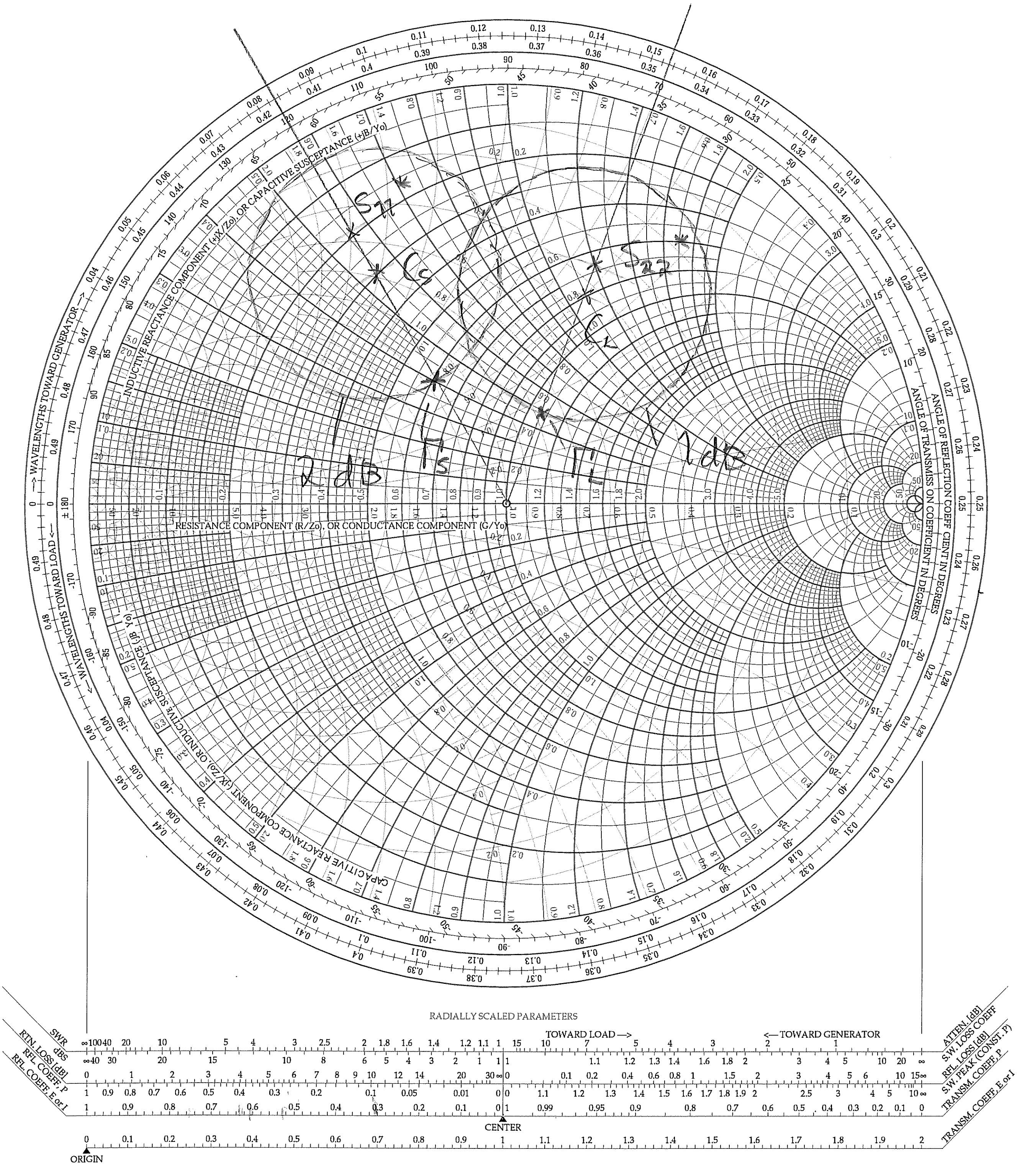
  $\Rightarrow \Gamma_L = 0{,}22\angle 70°$

* Matchning - - - -



NAME	TITLE	DWG. NO.
		DATE
SMITH CHART FORM ZY-01-N	Microwave Circuit Design - EE523 - Fall 2000	

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES



Γ_s, Γ_L

0,106λ

0,154λ

NAME	TITLE $d_l = 0{,}048\lambda$	DWG. NO. / DATE
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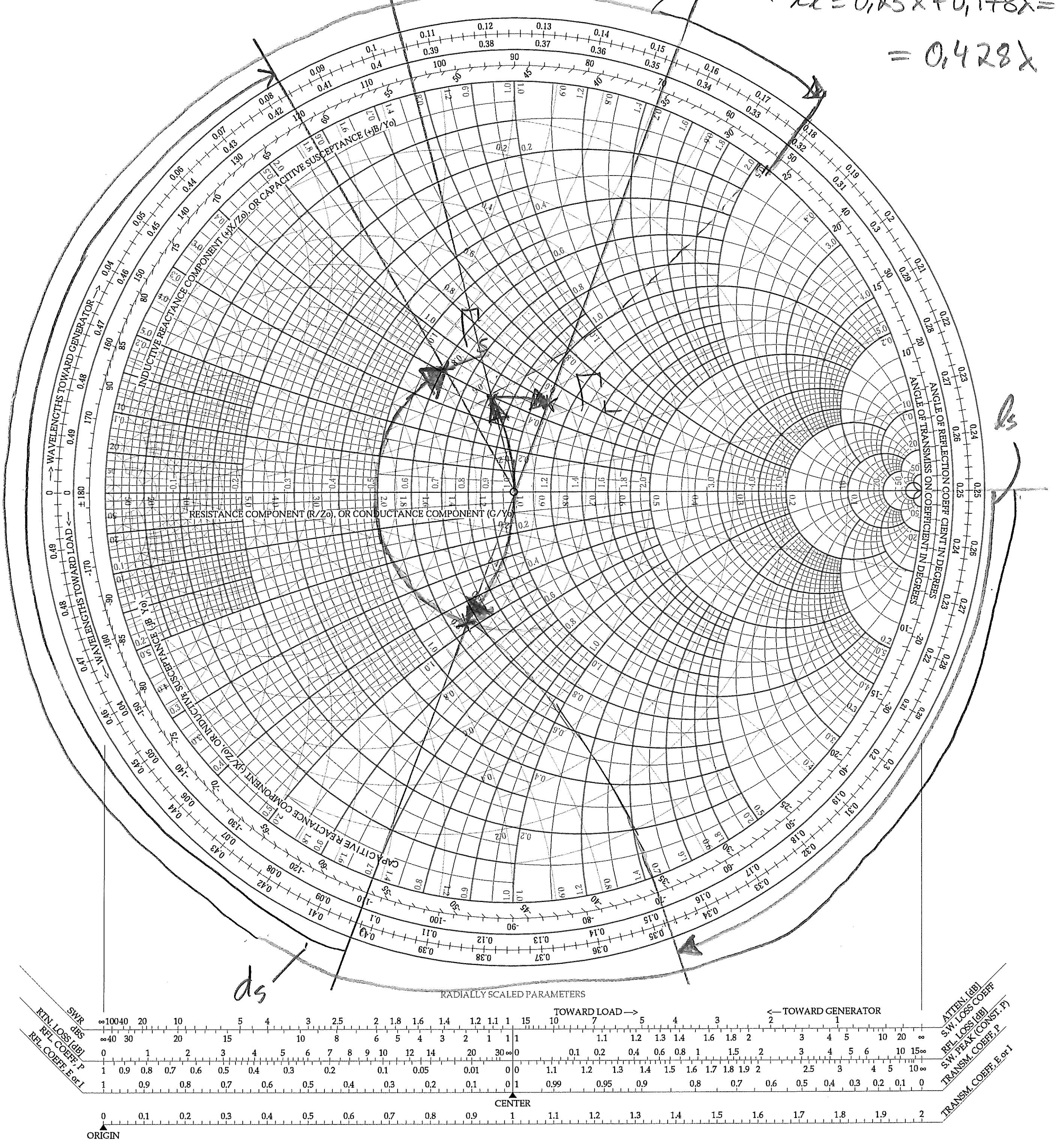
NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES

$l_l = 0{,}25\lambda + 0{,}178\lambda =$
$= 0{,}428\lambda$



$l_s = 0{,}348\lambda - 0{,}25\lambda = 0{,}098\lambda$

$d_s = 0{,}5\lambda - 0{,}405\lambda + 0{,}084\lambda = 0{,}179\lambda$

Tenta 170411, 4

LNA design, $f = 6$ GHz $G_T \geqslant 12$ dB

$NF \leq 1$ dB

$$[S] = \begin{bmatrix} 0{,}9\angle 180^\circ & 0\angle 0^\circ \\ 4\angle 180^\circ & 0{,}7\angle -90^\circ \end{bmatrix}$$

$\Gamma_{opt} = 0{,}7\angle 90^\circ$

ger F_{min} → $F_{min} = 0{,}5$ dB, $R_n = 50\ \Omega$

a) $\Gamma_s = ?$ $\Gamma_L = ?$

1. Är devicen stabil?

→ $S_{12} = 0$ (unilateral) ⇒ vi kan kolla på $|S_{11}|$, $|S_{22}|$. $|S_{11}| < 1$ och $|S_{22}| < 1$

$|S_{12}| = 0 \Rightarrow K = \infty$! $\Rightarrow |\Delta| < 1$

2.

Rita bruscirkeln $NF = 1$ $(F = 1)$

P. 6,63a $C_F = \dfrac{\Gamma_{opt}}{N+1}$ $N = \dfrac{F - F_{min}}{4R_n/Z_0}|1 + \Gamma_{opt}|^2$ P. 6,61

P. 6,63b radien $R_F = \dfrac{\sqrt{N(N+1-|\Gamma_{opt}|^2)}}{N+1} = 0{,}161$

$C_F = 0{,}67\angle 90^\circ$

- Hur mycket gain kan vi få maximalt? (fås vid konjugat matchning)

- Unilateral $\Rightarrow$ $\Gamma_{ms} = S_{11}^*$ $\Gamma_{ml} = S_{22}^*$

Gainet blir: $G_T = G_{TU,max}$

P.20 a-c

$$G_{TU,max} = \frac{1}{1-|S_{11}|^2} |S_{21}|^2 \frac{1}{1-|S_{22}|^2} = \underbrace{7{,}2 \text{ dB}}_{G_{s,max}} + 2{,}9 \text{ dB} +$$

$+ 12$ dB

- Välj $\Gamma_L = S_{22}^* = \underline{0{,}7\angle 90°}$

$\rightarrow$ Vi har $2{,}9 + 12$ dB gain nu

- Vi designar för exakt 12 dB gain (tacit)

$\Rightarrow$ Rita $\underline{G_s = -2{,}9 \text{ dB}}$ cirkeln

P. 6.54a $C_s = \dfrac{g_s S_{11}^*}{1-(1-g_s)|S_{11}|^2}$ $g_s = \dfrac{G_s}{G_{s,max}}$ P. 6.51a

$$R_s = \frac{\sqrt{1-g_s}\,(1-|S_{11}|^2)}{1-(1-g_s)|S_{11}|^2}$$

$R_s = \underline{0{,}67}$ $C_s = \underline{0{,}33\angle -180°}$

väljer vi för utgången

Rita in C_s, C_F, S_{11}^*, S_{22}^*, Γ_{opt}

vi väljer $\Gamma_s = 0{,}59\angle 92°$ (uppfyller målen. se 5.c)

Γ_s

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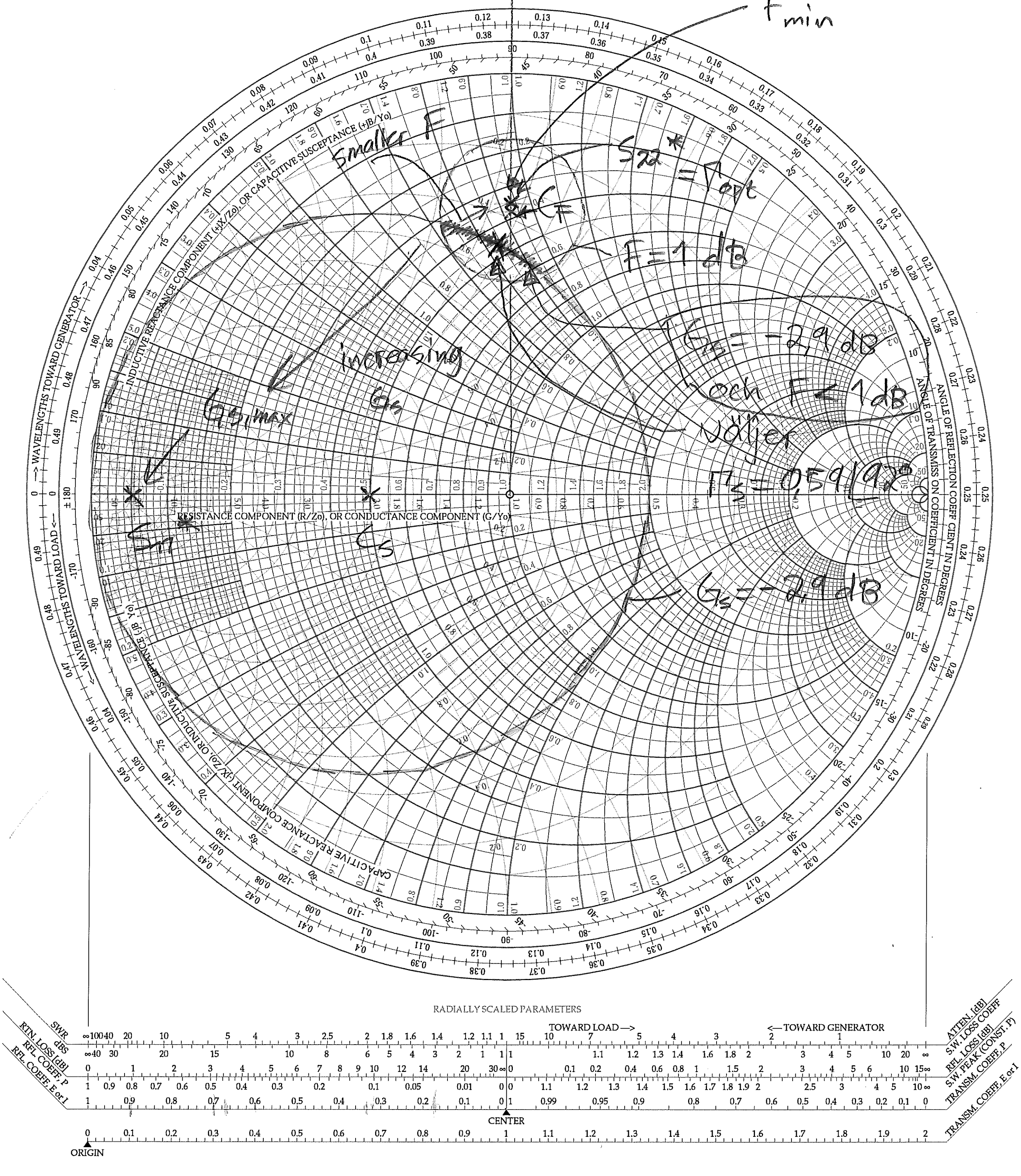
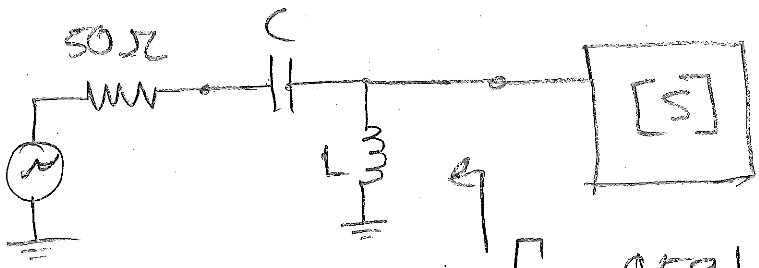


b) • L-anpassningsnät (lumped components) för ingång

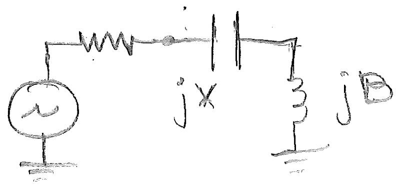
• Högpass karakteristik (serieelementet ska vara en kondensator):



$\Gamma_s = 0{,}59\angle 92°$

$$C = \frac{1}{\omega Z_0} = \_\_\_\_\_$$

$$L = \frac{1}{\omega 1{,}4 Y_0} = \_\_\_\_\_$$



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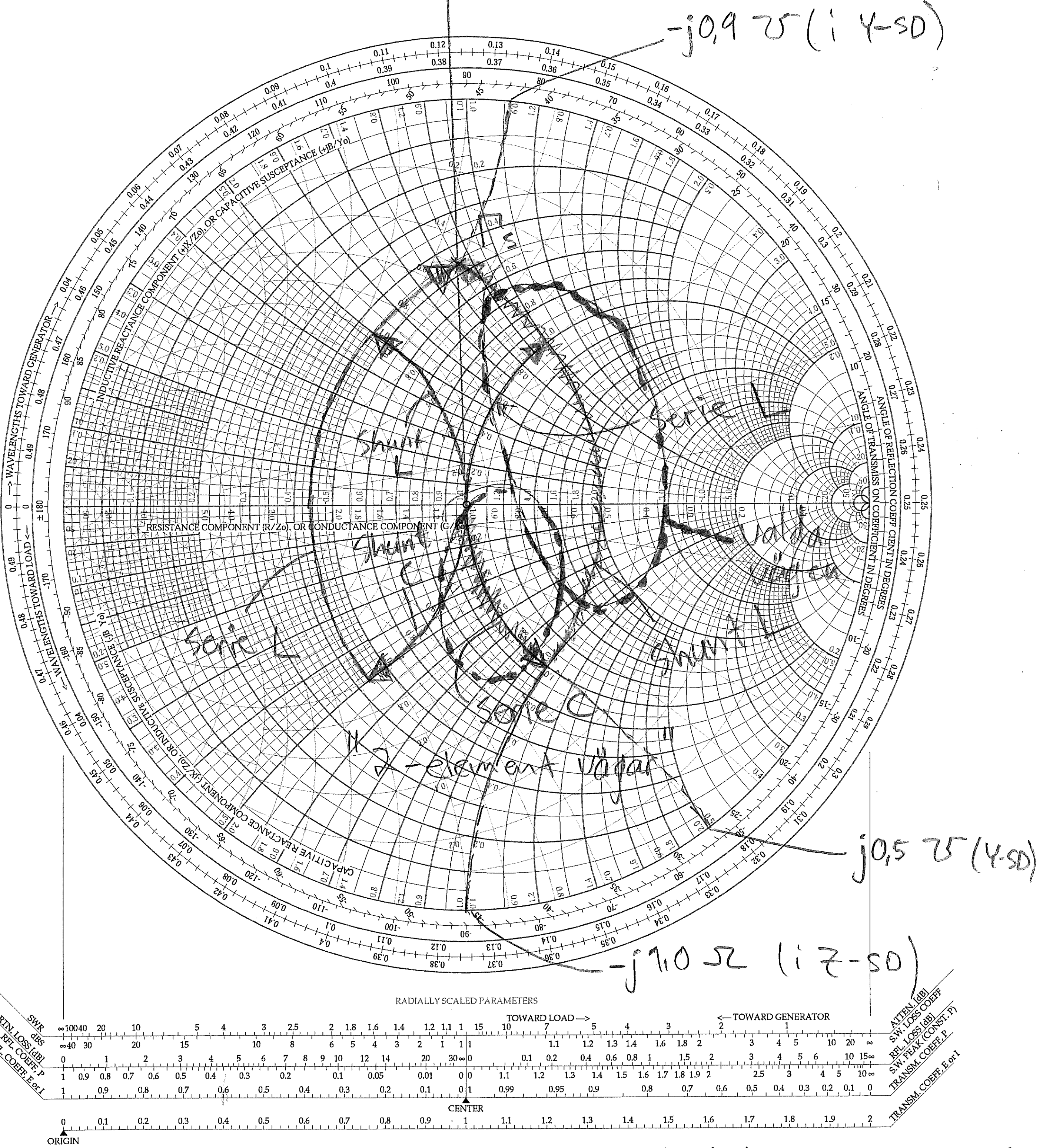

Serie C

$$\Delta = (-j1{,}0 - j0) Z_0 = -j\overset{=50}{Z_0} = -j\frac{1}{\omega C}$$

$$\Rightarrow C = \frac{1}{\omega Z_0}$$

Shunt L

$$\Delta = (-j0{,}9 - j0{,}5) Y_0 = -j1{,}4\,\overset{-j0{,}028}{Y_0}$$

$$\cancel{-j}1{,}4Y_0 = \cancel{-j}\frac{1}{\omega L}$$

$$\Rightarrow L = \frac{1}{\omega 1{,}4 Y_0}$$