3.3) (a) WITH THE VALUES GIVEN IN THE PROBLEM IT FOLLOWS THAT:

FROM (3.2.5): $\Gamma_{IN} = 0.671 \angle 160.72^\circ$

FROM (3.2.6): $\Gamma_{OUT} = 0.615 \angle -82.8^\circ$

FROM (3.2.1): $G_T = 8.575$ OR 9.33 dB

FROM (3.2.3): $G_p = 9.487$ OR 9.77 dB

FROM (3.2.4): $G_A = 8.745$ OR 9.42 dB

(b) $P_{AVS} = \dfrac{|E_1|^2}{8\,\mathrm{Re}[Z_1]} = \dfrac{10^2}{8(50)} = 0.25$ W, $M_s = \dfrac{G_T}{G_p} = \dfrac{8.575}{9.487} = 0.904$

$P_{IN} = P_{AVS} M_s = 0.25(0.904) = 0.226$ W

$P_L = G_p P_{IN} = 9.487(0.226) = 2.144$ W

$P_{AVN} = G_A P_{AVS} = 8.745(0.25) = 2.186$ W

3.4) $\Gamma_s = 0$ AND $\Gamma_L = 0.5 \angle 90^\circ$. HENCE:

$G_T = G_{TU} = 11.294$ OR 10.53 dB

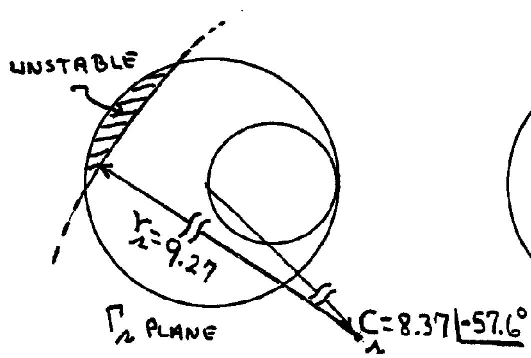
$G_p = 22.145$ OR 13.45 dB

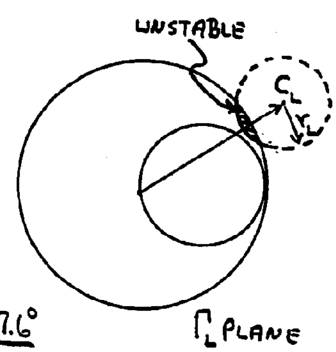
$G_A = 21.33$ OR 13.29 dB

3.7) (a) $K = 1.284$, $\Delta = 0.386 \angle 134.2^\circ$ $\therefore$ UNCONDITIONALLY STABLE.

(b) $K = 0.909$, $\Delta = 0.402 \angle -65.04^\circ$ $\therefore$ POTENTIALLY UNSTABLE.

INPUT STABILITY CIRCLE $\begin{cases} r_s = 9.27 \\ C_s = 8.37 \angle -57.6^\circ \end{cases}$ OUTPUT STABILITY CIRCLE $\begin{cases} r_L = 0.19 \\ C_L = 1.18 \angle 29.8^\circ \end{cases}$

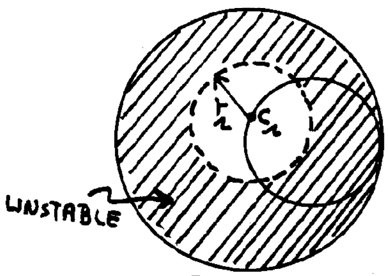




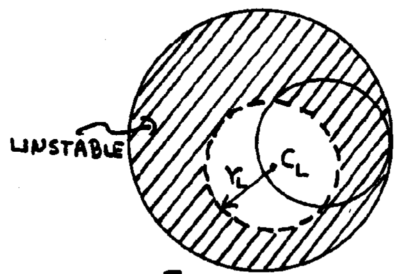
(c) $K = 1.202$, $\Delta = 1.76\angle 18.5°$ ∴ POTENTIALLY UNSTABLE

INPUT STABILITY CIRCLE $\begin{cases} r_s = 0.518 \\ C_s = 0.152\angle 82.1° \end{cases}$

OUTPUT STABILITY CIRCLE $\begin{cases} r_L = 0.494 \\ C_L = 0.239\angle -58° \end{cases}$



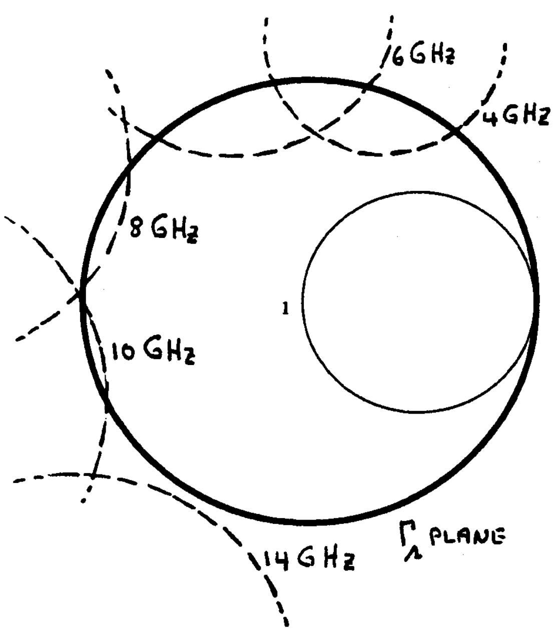
Γ_s PLANE

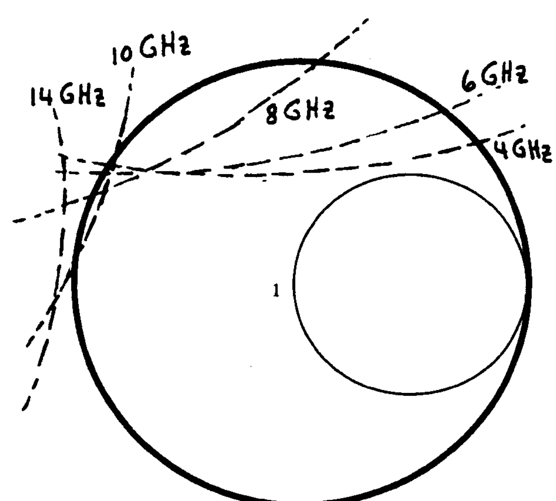


Γ_L PLANE

3.8)

f(GHz)	K	Δ	STABILITY CIRCLE	STABILITY CIRCLE
4	0.412	$0.65\angle -90.3°$	$r_s = 0.444$, $C_s = 1.25\angle 80.9°$	$r_L = 3.79$, $C_L = 4.3\angle 91.4°$
6	0.56	$0.57\angle -131.1°$	$r_s = 0.604$, $C_s = 1.43\angle 111.6°$	$r_L = 6.316$, $C_L = 6.93\angle 107.8°$
8	0.78	$0.43\angle 174.9°$	$r_s = 0.789$, $C_s = 1.69\angle 152.6°$	$r_L = 7.39$, $C_L = 8.2\angle 126.1°$
10	0.89	$0.32\angle 114°$	$r_s = 0.759$, $C_s = 1.72\angle -171.8°$	$r_L = 3.49$, $C_L = 4.41\angle 150.1°$
14	1.33	$0.17\angle -2.4°$	$r_s = 0.513$, $C_s = 1.62\angle -110.2°$	$r_L = 1.87$, $C_L = 3.08\angle -171.7°$



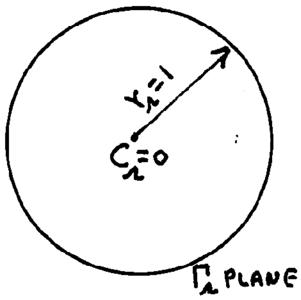


Γ_L PLANE

3.9) (a) $K=1$, $\Delta=1$

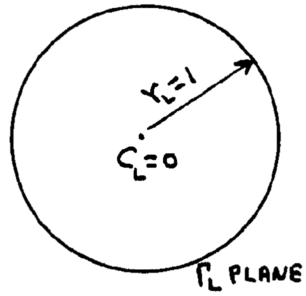
INPUT STABILITY CIRCLE:

$\begin{cases} r_s = 1 \\ C_s = 0 \end{cases}$



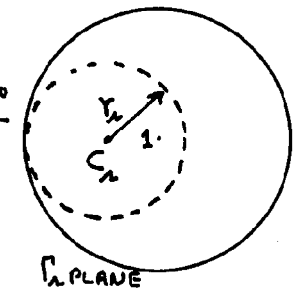
OUTPUT STABILITY CIRCLE:

$\begin{cases} r_L = 1 \\ C_L = 0 \end{cases}$

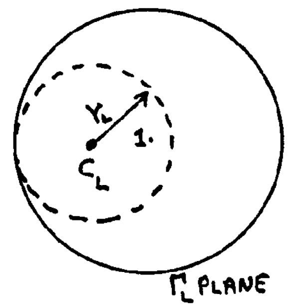


(b) $K=1$, $\Delta=-2.414$

$\begin{cases} r_s = 0.55 \\ C_s = 0.45\underline{|180°} \end{cases}$

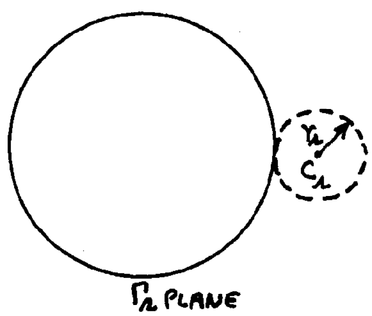


$\begin{cases} r_L = 0.55 \\ C_L = 0.45\underline{|180°} \end{cases}$

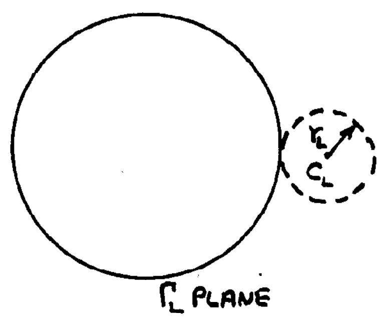


(c) $K=1$, $\Delta=0.415$

$\begin{cases} r_s = 0.26 \\ C_s = 1.26 \end{cases}$

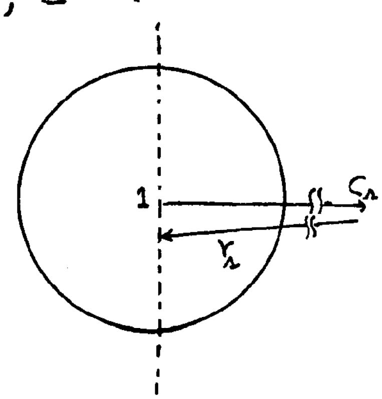


$\begin{cases} r_L = 0.26 \\ C_L = 1.26 \end{cases}$

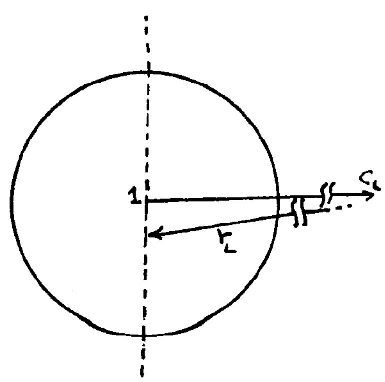


(d) $K=0$, $\Delta=-1$

$\begin{cases} r_s = \infty \\ C_s = \infty \end{cases}$



$\begin{cases} r_L = \infty \\ C_L = \infty \end{cases}$



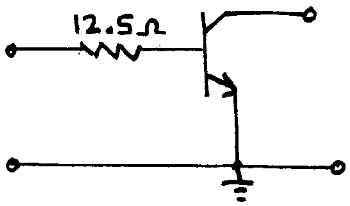
3.14) FOR THIS TRANSISTOR: $K = 0.532$, $\Delta = 0.617\angle{-85.4^\circ}$

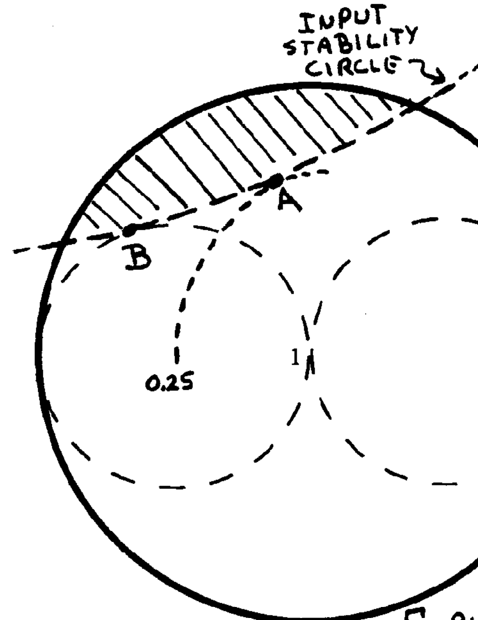
$r_s = 1.96$ $\quad$ $r_L = 0.576$

$C_s = 2.64\angle{116.7^\circ}$ $\quad$ $C_L = 1.4\angle{41.5^\circ}$

AT POINT A: $r = 0.25$

$\therefore R = 0.25(50) = 12.5\,\Omega$

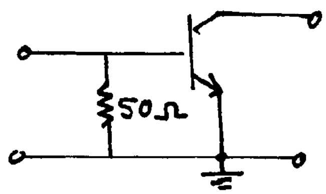




Γ_s PLANE

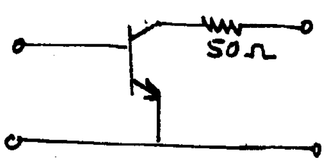
AT POINT B: $g = 1$

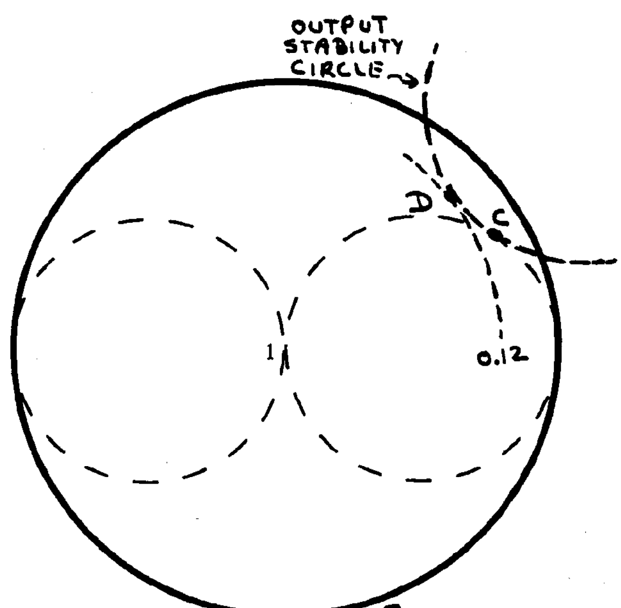
$\therefore G = \frac{1}{50} = 20\,mS$ (OR $50\,\Omega$)



AT POINT C : $r = 1$

$\therefore R = 1(50) = 50\,\Omega$

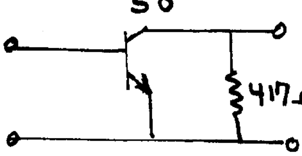




Γ_L PLANE

AT POINT D: $g = 0.12$

$G = \frac{0.12}{50} = 2.4\,mS$ (OR $417\,\Omega$)



FOR THIS CIRCUIT IT FOLLOWS THAT: $S_{11} = 0.695\angle{-77.3^\circ}$, $S_{12} = 0.03\angle{42.5^\circ}$, $S_{21} = 5.13\angle{124.1^\circ}$, AND $S_{22} = 0.665\angle{-25.8^\circ}$.

HENCE, $K = 1.02$ AND $\Delta = 0.488\angle{-84.7^\circ}$ AND THE CIRCUIT IS UNCONDITIONALLY STABLE.

3.16) (a) For $G_{TU,max}$: $\Gamma_s = S_{11}^* = 0.706\angle 160^\circ$ and

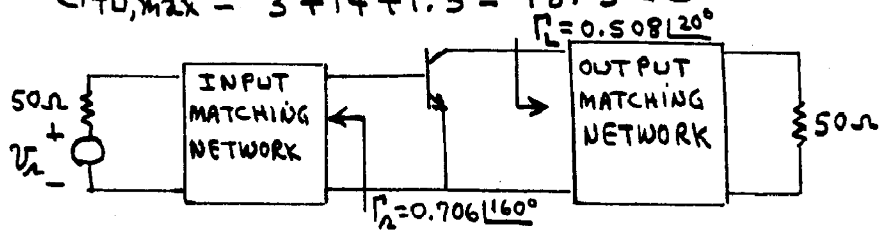
$\Gamma_L = S_{22}^* = 0.508\angle 20^\circ$.

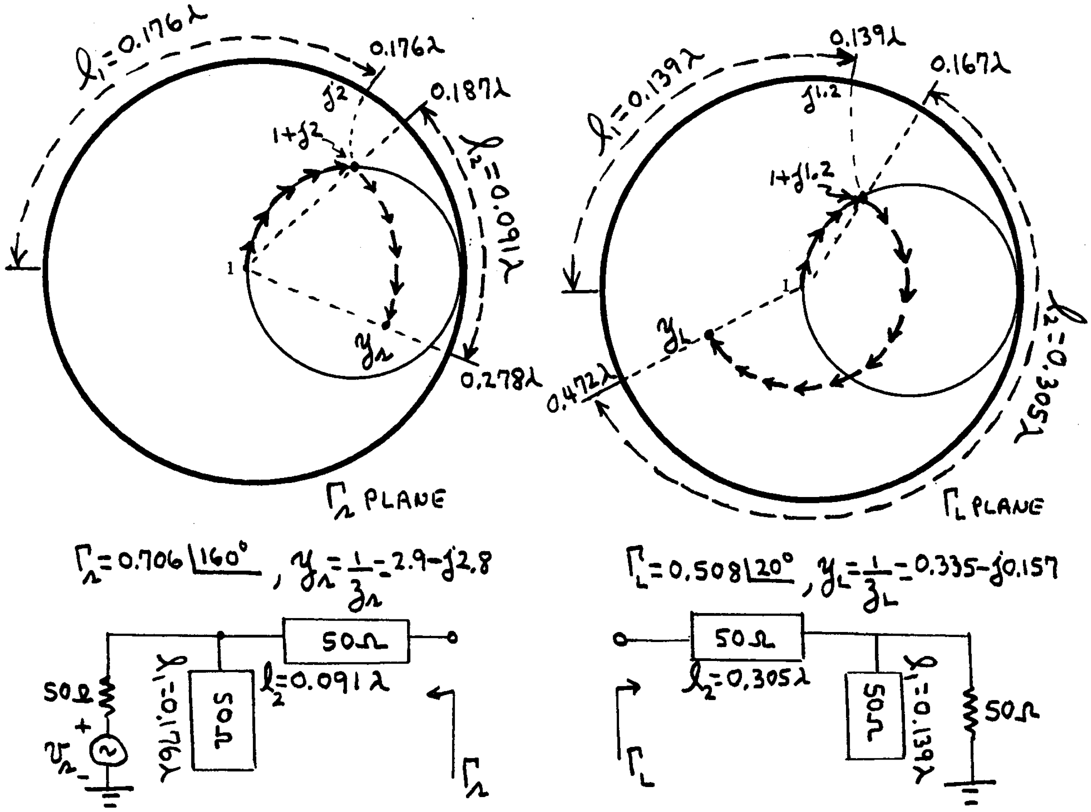
$$G_{s,max} = \frac{1}{1-|S_{11}|^2} = \frac{1}{1-(0.706)^2} = 1.99 \text{ or } 3\text{ dB}$$

$$G_o = |S_{21}|^2 = (5.01)^2 = 25.1 \text{ or } 14\text{ dB}$$

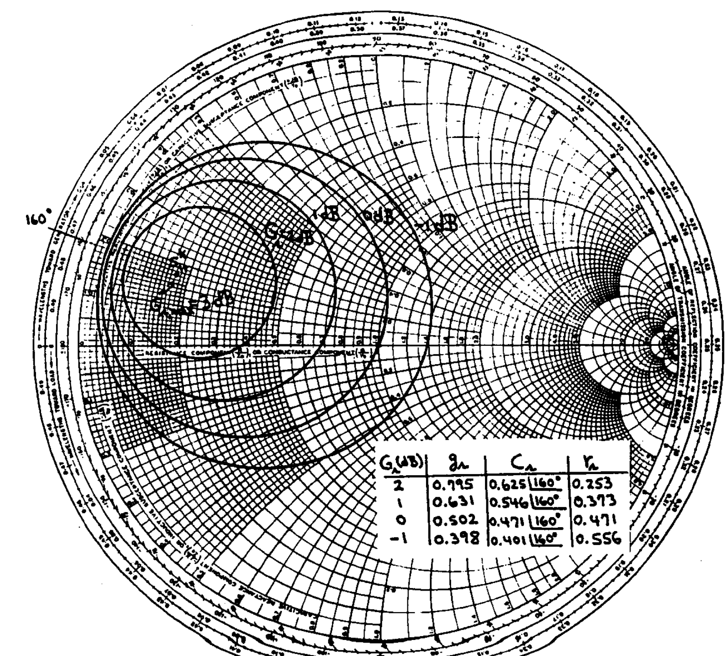
$$G_{L,max} = \frac{1}{1-|S_{22}|^2} = \frac{1}{1-(0.508)^2} = 1.35 \text{ or } 1.3\text{ dB}$$

$$G_{TU,max} = 3 + 14 + 1.3 = 18.3\text{ dB}$$





(b)



G_s(dB)	g_s	C_s	r_s
2	0.795	$0.625\angle 160°$	0.253
1	0.631	$0.546\angle 160°$	0.373
0	0.502	$0.471\angle 160°$	0.471
−1	0.398	$0.401\angle 160°$	0.556

3.17) (a) THE INPUT RESISTANCE IS CALCULATED AS FOLLOWS:

$\Gamma_{IN} = S_{11} = 2.3\angle{-135^\circ}$, $Z_{IN} = 50(-0.45 - j0.341) = -22.48 - j17.04\ \Omega$.

Z_{IN} CAN ALSO BE CALCULATED USING THE SMITH CHART.

PLOT $\frac{1}{S_{11}^*} = 0.435\angle{-135}$ AND READ $Z_{IN} = 50(-0.45 - j0.34) = -22.5 - j17\ \Omega$

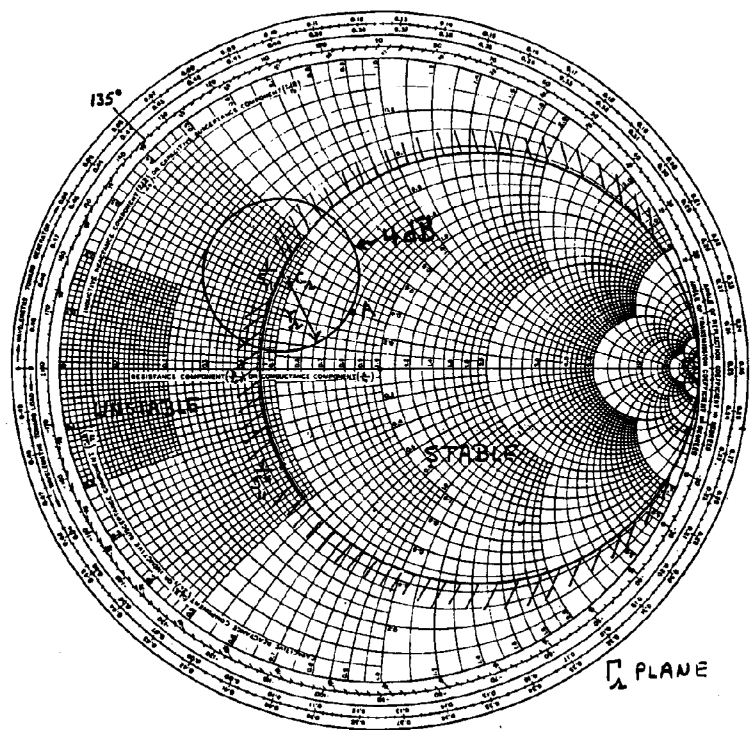
FOR $G_s = 4$ dB , $g_s = 2.512[1-(2.3)^2] = -10.78$

FROM (3.4.11) AND (3.4.12): $C_s = 0.404\angle{135^\circ}$ AND $r_s = 0.24$

(b) AT POINT A, Γ_s HAS THE LARGEST REAL PART ON THE $G_s = 4$ dB CIRCLE. THAT IS,

$\Gamma_s = 0.2\angle{115^\circ}$

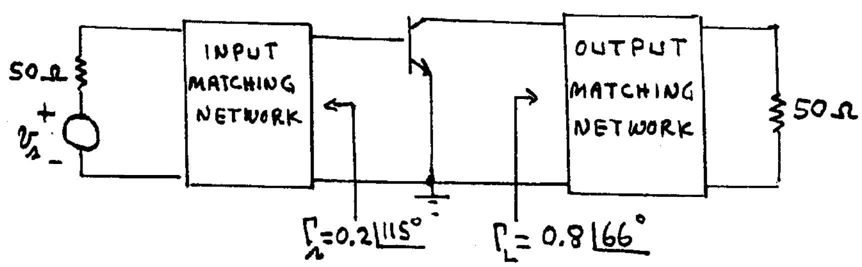
THE INPUT MATCHING CIRCUIT MUST TRANSFORM $50\ \Omega$ TO $\Gamma_s = 0.2\angle{115^\circ}$.



(c) DESIGN FOR $\Gamma_s = 0.2\angle{115^\circ}$ AND $\Gamma_L = S_{22}^* = 0.8\angle{66^\circ}$. THEN,

$G_s = 4$ dB, $G_o = |S_{21}|^2 = 16$ (OR 12.04 dB), $G_{L,max} = \frac{1}{1-(0.8)^2} = 2.78$ (OR 4.4 dB)

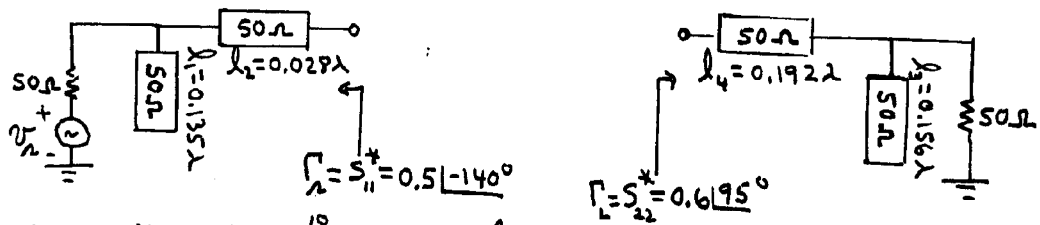
$\therefore\ G_{TU}(\text{dB}) = G_s + G_o + G_{L,max} = 4 + 12.04 + 4.4 = 20.4$ dB



3.18) (a) $G_{s,max} = \frac{1}{1-(0.5)^2} = 1.33$ OR 1.25 dB, $G_{L,max} = \frac{1}{1-(0.6)^2} = 1.563$ OR 1.94 dB

$G_o = |S_{21}|^2 = 25$ OR 13.98 dB, $\therefore G_{TU,max} = 1.25 + 13.98 + 1.94 = 17.2$ dB

(b) A MATCHING NETWORK DESIGN AT 900 MHz IS:



AT 900 MHz: $\lambda = \frac{3\,10^{10}}{9\,10^8} = 33.3$ cm, $\ell_1 = 0.135\lambda = 4.496$ cm,

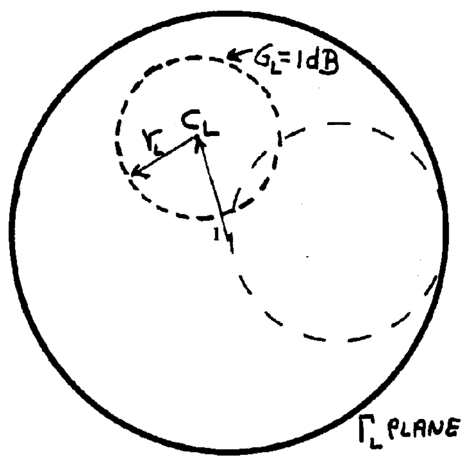
$\ell_2 = 0.028\lambda = 0.932$ cm, $\ell_3 = 0.156\lambda = 5.195$ cm, $\ell_4 = 0.192\lambda = 6.394$ cm

(c) $g_L = \frac{G_L}{G_{L,max}} = \frac{1.259}{1.563} = 0.805$

FROM (3.4.11) AND (3.4.12):

$C_L = 0.519\angle 95^\circ$

$r_L = 0.304$



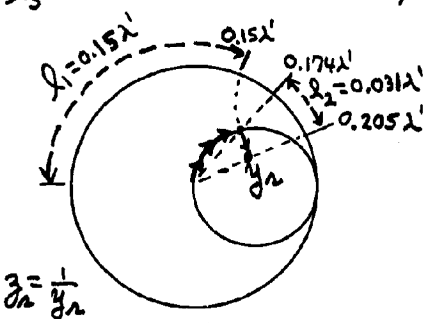
(d) LET $\lambda' = \frac{c}{f'}$ WHERE $f' = 1$ GHz,

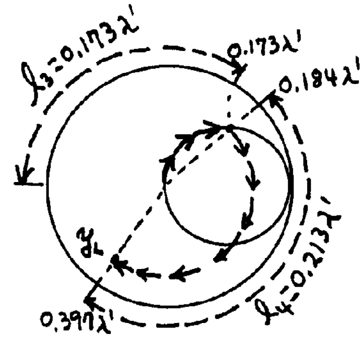
AND $\lambda = \frac{c}{f}$ WHERE $f = 900$ MHz.

$\therefore \frac{\lambda}{\lambda'} = \frac{f'}{f}$ OR $\lambda = \frac{f'}{f}\lambda' = \frac{10^9}{9\,10^8}\lambda' = 1.11\lambda'$

$\ell_1 = 0.135\lambda = 0.135(1.11\lambda') = 0.15\lambda'$, $\ell_2 = 0.028(1.11\lambda') = 0.031\lambda'$,

$\ell_3 = 0.156(1.11\lambda') = 0.173\lambda'$, $\ell_4 = 0.192(1.11\lambda') = 0.213\lambda'$





$y_s = 1.79 + j1.58$, $\Gamma_s = 0.55\angle{-146^\circ}$ $\qquad$ $y_L = 0.28 - j0.72$, $\Gamma_L = 0.693\angle 74.4^\circ$

$$\therefore G_{TU} = \frac{1-(0.55)^2}{|1-0.48\angle 137^\circ(0.55\angle{-146^\circ})|^2}(4.6)^2\frac{1-(0.693)^2}{|1-0.57\angle{-99^\circ}(0.693\angle 74.4^\circ)|^2} = 31.97 \text{ OR } 15.05 \text{ dB}$$

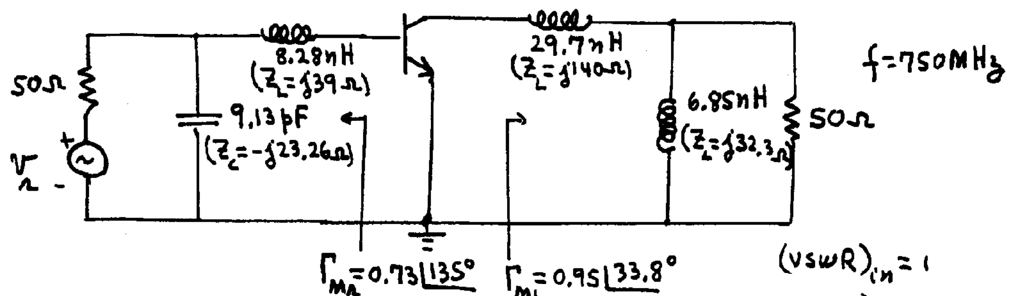
3.21) $K = 1.03$ AND $\Delta = 0.324\angle -64.8°$ $\therefore$ UNCONDITIONALLY STABLE

FROM (3.6.5) : $\Gamma_{Ms} = 0.73\angle 135°$

FROM (3.6.6) : $\Gamma_{ML} = 0.95\angle 33.8°$

FROM (3.6.10) : $G_{T,max} = 19.08$ OR 12.8 dB

A DESIGN USING LUMPED ELEMENTS IS :



$(VSWR)_{in} = 1$

$(VSWR)_{out} = 1$

A DESIGN USING MICROSTRIP LINES IS :