Some HW-2 problem solutions for ECE 432/532

This set of solutions is provided for your convenience and should under NO circumstances be shared with anyone outside of the class (ECE 432/532)

Prob. 3.21:

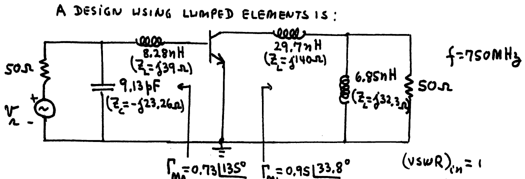
3.21) $K = 1.03$ AND $\Delta = 0.324\angle{-64.8°}$ ∴ UNCONDITIONALLY STABLE

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

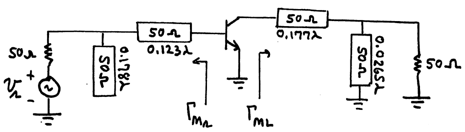
A DESIGN USING LUMPED ELEMENTS IS:



$(VSWR)_{in} = 1$

$(VSWR)_{out} = 1$

A DESIGN USING MICROSTRIP LINES IS:



Prob. 3.22:

3.22) (a) THE ADMITTANCE OF THE 70 Ω STUB IS: $y_{oc} = j$ OR $Y_{oc} = \frac{j}{70}$

THE ADMITTANCE OF THE TWO PARALLEL STUBS IS:

$$Y_{oc,TOTAL} = \frac{j}{70} + \frac{j}{70} = \frac{2j}{70} = \frac{j}{35} = j29 \text{ mS}$$

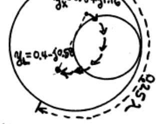
THE ADMITTANCE OF THE 50-Ω LOAD PLUS $Y_{oc,TOTAL}$ IS (CALLED Y_x):

$$Y_x = \frac{1}{50} + \frac{j}{35} = 20 + j29 \text{ mS}$$

NORMALIZING Y_x WITH $Y_{o1} = \frac{1}{Z_{01}} = \frac{1}{40}$ ($y_x = 0.8 + j1.16$)

AND ROTATING IN THE SMITH CHART A DISTANCE $l = 0.25\lambda$ GIVES

$z_L = \frac{1}{y_L} = 0.8 + j1.16$ ∴ $\Gamma_L = \Gamma_{ML} = 0.55\angle{67°}$



(b) FROM FIG. 2.5.4 (WITH $\epsilon_r = 10$ AND $h = 30$ mils):

$W = 28.5$ mils AND $\epsilon_{ff} = 6.68$, $\lambda_o = \frac{3\,10^{10}}{2\,10^{9}} = 15$ cm.

∴ $l_1 = 0.25\lambda = \frac{0.25\lambda_o}{\sqrt{\epsilon_{ff}}} = \frac{0.25(15)}{\sqrt{6.68}} = 1.45$ cm.

Prob. 3.25:

3.25) (a) THE TRANSISTOR IS UNCONDITIONALLY STABLE ($K = 1.033$, $\Delta = 0.324\angle{-64.8°}$)

WITH $g_p = \frac{G_p}{|S_{21}|^2} = \frac{10^1}{(1.92)^2} = 2.713$, WE OBTAIN FROM (3.7.4) AND (3.7.5):

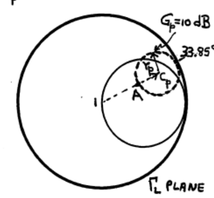
$$C_p = 0.781\angle{33.85°} \quad \text{AND} \quad r_p = 0.214$$

THE $G_p = 10$dB GAIN CIRCLE IS DRAWN IN THE SMITH CHART. SELECTING Γ_L AT POINT "A": $\Gamma_L = 0.567\angle{33.85°}$, GIVES

$\Gamma_s = \Gamma_{IN}^* = 0.276\angle{93.33°}$.

AND

$\Gamma_{OUT} = 0.86\angle{-33.85°}$



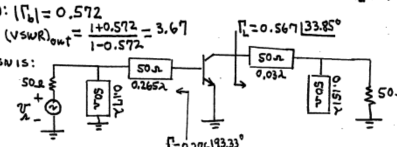
FROM (2.8.3): $|\Gamma_a| = 0$ (SINCE $\Gamma_s = \Gamma_{IN}^*$)

HENCE: $(VSWR)_{in} = 1$

FROM (2.8.6): $|\Gamma_b| = 0.572$

HENCE: $(VSWR)_{out} = \frac{1+0.572}{1-0.572} = 3.67$

A DESIGN IS:



(b) $G_{p,max} = G_{T,max} = 19.08$ OR 12.8 dB

THE $G_{p,max}$ GAIN CIRCLE (i.e, a point) OCCURS AT:

$g_{p,max} = \frac{G_{p,max}}{|S_{21}|^2} = \frac{19.08}{(1.92)^2} = 5.176$; $C_{p,max} = 0.95\angle{33.8°}$, $r_{p,max} = 0$.

OBSERVE (SEE PROBLEM 3.21) THAT: $\Gamma_{ML} = C_{p,max} = 0.95\angle{33.8°}$

AND $\Gamma_s = \Gamma_{IN}^* = 0.73\angle{135°}$ IS IDENTICAL TO Γ_{Ms}.

Prob. 3.26:

3.26) FOR THIS TRANSISTOR: $K = 1.053$ AND $\Delta = 0.576\angle{-85.4°}$.

THEREFORE, IT IS UNCONDICIONALLY STABLE.

$$G_{p,max} = G_{T,MAX} = 77.12 \text{ OR } 18.87 \text{ dB}$$

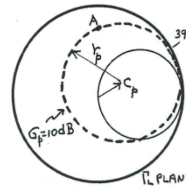
$G_p = 10$dB CIRCLE: $g_p = 0.977$, $C_p = 0.306\angle{39.45°}$, $r_p = 0.693$

THE $G_p = 10$ dB CONSTANT-GAIN CIRCLE IS SHOWN IN THE SMITH CHART. THE Γ_L SELECTED IS SHOWN AS "A": $\Gamma_L = 0.85\angle{89°}$.

THEN: $\Gamma_s = \Gamma_{IN}^* = 0.793\angle{64.2°}$, $\Gamma_{OUT} = 0.798\angle{-42.3°}$

$|\Gamma_a| = 0$, $(VSWR)_{in} = 1$

$|\Gamma_b| = 0.9$, $(VSWR)_{out} = 18.9$



Prob. 4.3:

4.3) (a) THE $G_A = 14$ dB CIRCLE AND THE $F = 2$ dB CIRCLE INTERSECT AT TWO POINTS. THE VALUE OF Γ_s AT THESE THE POINTS ARE:

$$\Gamma_s \approx 0.5\angle{160°} \quad \text{AND} \quad \Gamma_s \approx 0.25\angle{-150°}$$

(b) LET $\Gamma_s = 0.5\angle{160°}$, THEN $\Gamma_{OUT} = 0.657\angle{-73.3°}$

FOR $(VSWR)_{OUT} = 1$: $\Gamma_L = \Gamma_{OUT}^* = 0.657\angle{73.3°}$

THEN, $\Gamma_{IN} = 0.8\angle{165.6°}$, $|\Gamma_a| = 0.678$, $(VSWR)_{in} = 5.2$

Prob. 4.4:

4.4) (a) $K = 2.25$ AND $\Delta = 0.246\angle 112.8^\circ$ ∴ UNCONDITIONALLY STABLE

(b) $G_{A,max} = \frac{|S_{21}|}{|S_{12}|}\left(K - \sqrt{K^2-1}\right) = 9.36$ OR 9.71 dB

(c) $G_A = 9.71 - 3 = 6.71$ dB

FOR THE $G_A = 6.71$ dB CIRCLE: $g_a = 1.173$,

$C_a = 0.42\angle 174.5^\circ$, $r_a = 0.515$

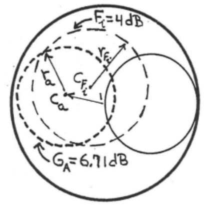
(d) FOR THE 3dB NOISE CIRCLE:

$C_{F_i} = 0.405\angle 145^\circ$, $r_{F_i} = 0.388$

FOR THE 4 dB NOISE CIRCLES:

$C_{F_i} = 0.279\angle 145^\circ$, $r_{F_i} = 0.616$

THE $F_i = 4$ dB CIRCLE IS DRAWN ON THE SMITH CHART.



Γ_s PLANE

(e) FOR $G_{A,max}$: $\Gamma_s = \Gamma_{Ms} = 0.667\angle 174.5^\circ$, $\Gamma_L = \Gamma_{ML} = 0.587\angle 102.2^\circ$.

$$\therefore F = 10^{0.25} + \frac{4\left(\frac{5}{50}\right)\left|0.667\angle 174.5^\circ - 0.5\angle 145^\circ\right|^2}{\left(1-(0.667)^2\right)\left|1+0.5\angle 145^\circ\right|^2} = 1.97 \text{ OR } 2.95\text{ dB}$$

Prob. 4.8:

4.8) $K = 0.96$, $\Delta = 0.6\angle -73.1^\circ$ ∴ POTENTIALLY UNSTABLE

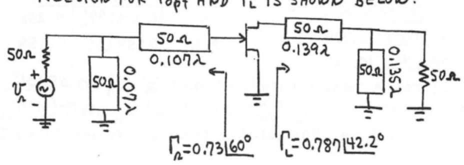
INPUT STABILITY CIRCLE: $C_s = 1.34\angle 62.7^\circ$, $r_s = 0.345$

OUTPUT STABILITY CIRCLE: $C_L = 1.55\angle 47.2^\circ$, $r_L = 0.56$

DESIGN WITH $\Gamma_s = \Gamma_{opt} = 0.73\angle 60^\circ$ AND $\Gamma_L = \Gamma_{OUT}^* = 0.787\angle 42.2^\circ$

BOTH Γ_{opt} AND Γ_L ARE IN THE STABLE REGION (AS EXPECTE]

A DESIGN FOR Γ_{opt} AND Γ_L IS SHOWN BELOW:



$G_A = 14.9$

$F = 1.25$

$(VSWR)_{in} = 2$

$(VSWR)_{OUT} =$

Pozar - part 1:

ECE 432/532 HW 2

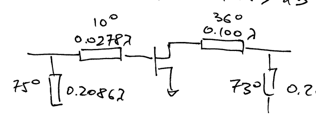
Pozar

12.9 $\Gamma_S = \Gamma_{in}^* = 0.883\angle -172^\circ$

$\Gamma_L = \Gamma_{out}^* = 0.859\angle 139^\circ$

$G_S = 4.53$ $G_0 = 4.00$ $G_L = 0.623$

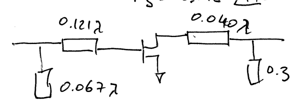
$G_T = 11.29 \rightarrow = 10.53$ dB



12.12 $G_{S\,max} = 1.59$ $G_{L\,max} = 2.08$

construct circles for $g_S = 0.792$ & $g_L = 0.760$

One choice: $\Gamma_S = 0.215\angle 170^\circ$, $\Gamma_L = 0.361\angle 83^\circ$



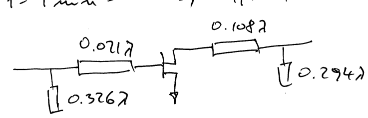
Pozar – part 2

-2-

Pozar

12.15 $\Gamma_L = 0.873\angle 74^\circ$

$F = F_{min} = 2.5$dB, $G_T = 19.4$dB



12.16. Plot const. noise circles for $F = 2.05$, 2.20, 3.00 & 2.0 dB

+ circles for $G_S = G_L = 0$ dB

- chose $\Gamma_L = 0.66\angle 105^\circ$ & $\Gamma_S = 0.62\angle 105^\circ$

$\Rightarrow F \cong 2.05$dB