EE 458/
EE 558

Microwave Circuit Design and Measurements Laboratory

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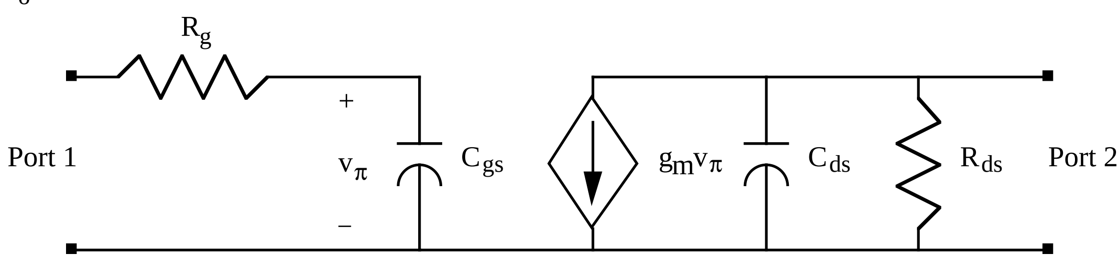
Final Exam
12/14/01

This is a closed book, closed notes test; you may, however, use your laboratory notebook for reference. You may use calculators for numerical calculations, but you must show your work and sufficient intermediate results to justify your answers; please write down the equations that you use symbolically prior to plugging in any numbers. **Please label and circle or box your answers so that I can find them.**

Problem 1 (30 pts): For the transistor equivalent circuit shown below, the reference impedance of port 1 and 2 is $Z_o = 50\ \Omega$.



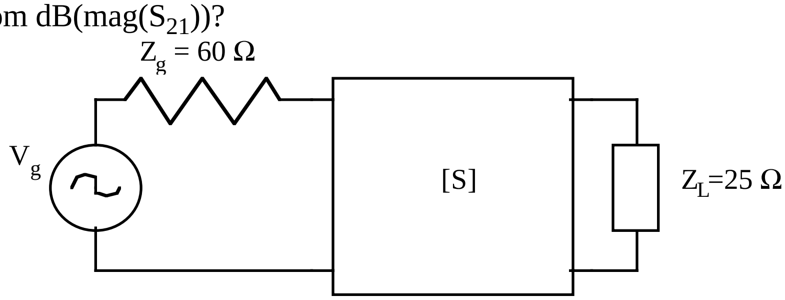
a.) Find the S matrix for this circuit in terms of the circuit parameters (R's, C's, etc.). Evaluate the s-parameter matrix numerically at f=1 GHz, if $R_g = 2\ \Omega$, $C_{gs} = 0.5$ pF, $g_m = 0.1$ S, $C_{ds} = 0.5$ pF, and $R_{ds} = 200\ \Omega$.

b.) If Port 2 is terminated with a $\lambda/4$ length of 100 Ω transmission line terminated in 50 Ω, what is the return loss (in dB) at Port 1?

c.) Describe (in words) what is meant by "unconditional stability." Using the Rowlett stability factor (k), determine if this transistor above unconditionally stable at 1 GHz. Comment on any specific features of this device the contribute to either the instability or stability of the device.

Problem 2 (20 pts):

Explain (in words) the significance/meaning of operating power gain (G_P), transducer gain (G_T), and available gain (G_A) and the distinctions between these gains. For the figure and s-parameter matrix below, compute the numerical value of G_T, and express the result in dB. Why is this different from dB(mag(S_{21}))?



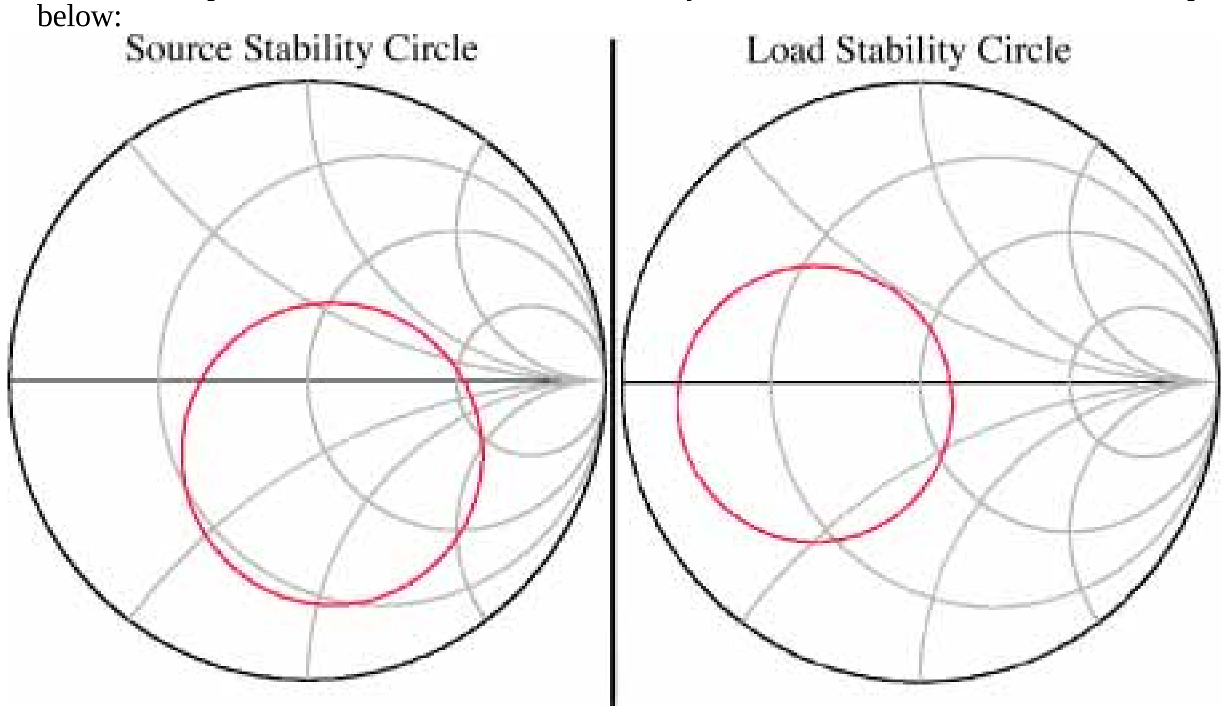
50 Ω s-parameters: $[S]=\begin{bmatrix} 0.75\angle -80^\circ & 0.7\angle 40^\circ \\ 3.5\angle -135^\circ & 0.3\angle 40^\circ \end{bmatrix}$

Problem 3 (20 pts):

The s-parameters of an amplifier have been measured, and at a particular frequency are:

$$[S]=\begin{bmatrix} 0.75\angle -80^\circ & 0.7\angle 40^\circ \\ 3.5\angle -135^\circ & 0.3\angle 40^\circ \end{bmatrix}$$

From these s-parameters the source and load stability circles have been determined, and are plotted below:

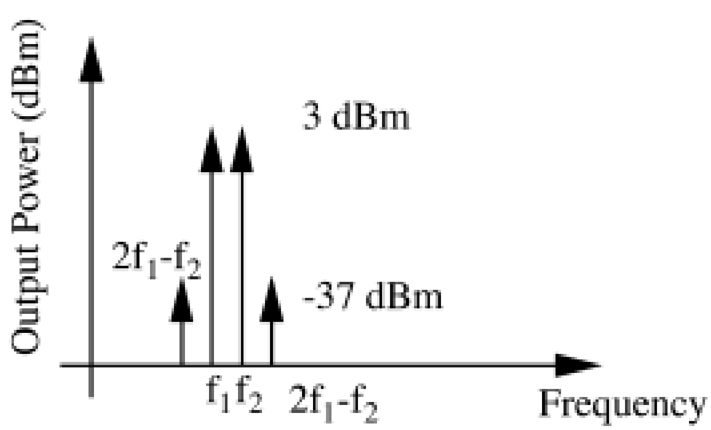


a.) Is this amplifier stable for a 50 Ω source and load?

b.) Is this amplifier stable if the output is terminated with a 25 Ω resistor? With a 100 Ω resistor?

Problem 4 (30 pts):

Two signals at closely spaced frequencies f_1 and f_2 are applied to the input of an amplifier. The available input power for each of the signals is -20 dBm. The following display is seen when the output of the amplifier is connected to a spectrum analyzer:



a.) Find the intermodulation ration (IMR) and the 3rd-order input intercept (IP3) for this amplifier. You may assume that gain compression is not significant.

b.) What is the transducer power gain (G_T) of this amplifier?

c.) Describe in words what is meant by the term “desensitization.” In your discussion, be sure to address the symptoms of this effect as well as the source(s) that contribute to the effect.