ECE 145a /218A problem set:
Bilateral Reactively matched ampliers and stability.

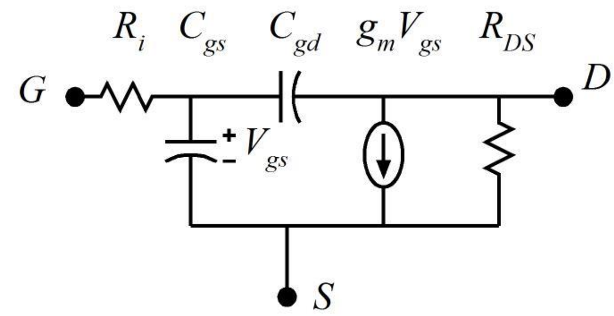
Problem 1:

$g_m = 2mS/\mu m \cdot W_g \quad R_i = 1/g_m$

$C_{gd} = 0.5\,fF/\mu m \cdot W_g$

$C_{gs} = 1\,fF/\mu m \cdot W_g$

$G_{ds} = 0.5mS/\mu m \cdot W_g$



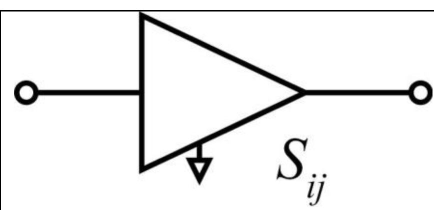
part a) Taking W_g =50 microns for the bilateral device model, Plot the MAG/MSG stability factor K and B1 for the device of problem 1 vs frequency. At what frequencies is the device unconditionally stable ? At a design frequency of 10GHz, what is the maximum stable gain ? Calculate this by hand (!) and then compare to the ADS simulation.

part b) Plot the device source and load stability circles at 10 GHz. What value of series resistance on the input would stablilize the device ? What parallel input resistance ? Repeat for the output.

part c) Add series stabilization on the input so that the stablized MAG is 1 dB less than the transistor MSG at 10 GHz. Plot the input and output Ga and Gp circles at 10 GHz. Design matching networks at 10 GHz. Plot all 4 S-parameters vs frequency, and compare the peak S21 obtained to the transistor MSG.

Problem 2: An amplifier has the following S parameters

S11=S22=0
S21=2
S12=1



part a) Using a 50 Ohm reference impedance, compute the source and load stability circles, and draw them carefully on separate Smith charts.

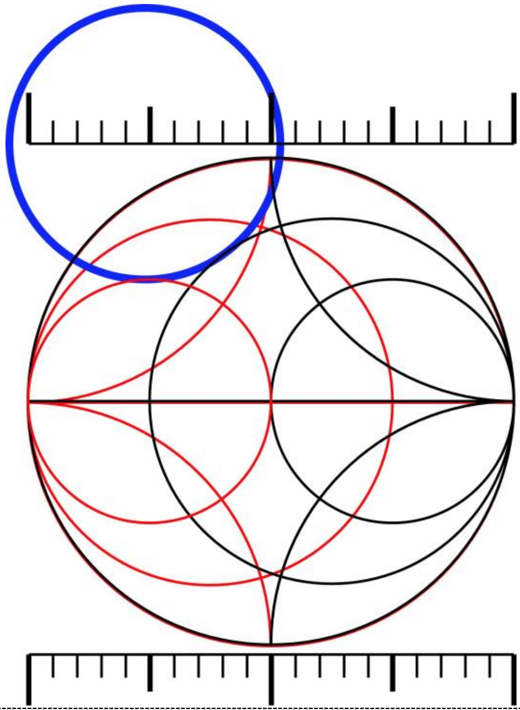
part b) Is the device unconditionally stable or potentially unstable ? Note: It is not sufficient to check K alone.

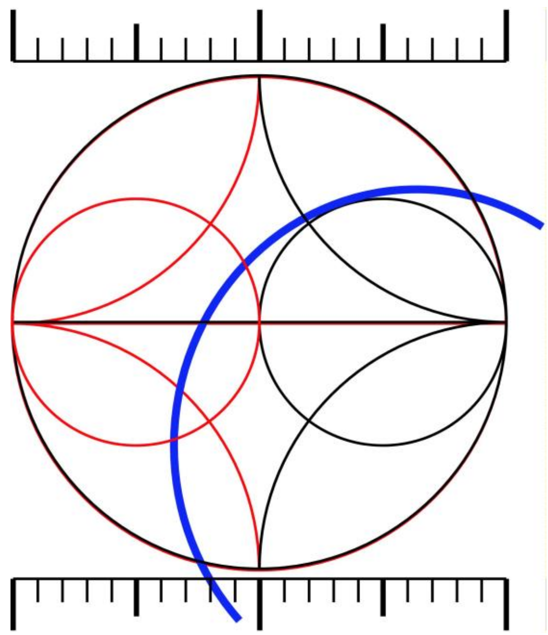
part c) The network can be stabilized by an attenuator, ie a device with S11=S22=0 S21=X=S12. What maximum value of X is allowable for unconditional stability ?

part d) After you have stabilized the device, and then matched input and output, what power gain will you obtain ?

Problem 3:

Source stability circle	load stability circle

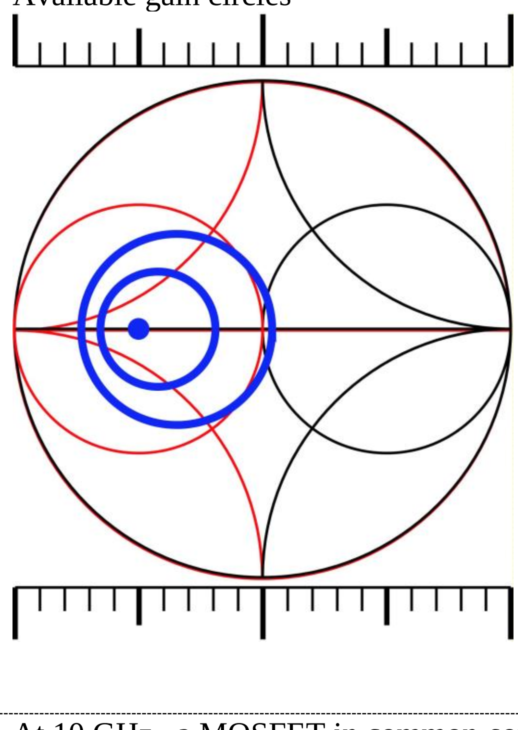




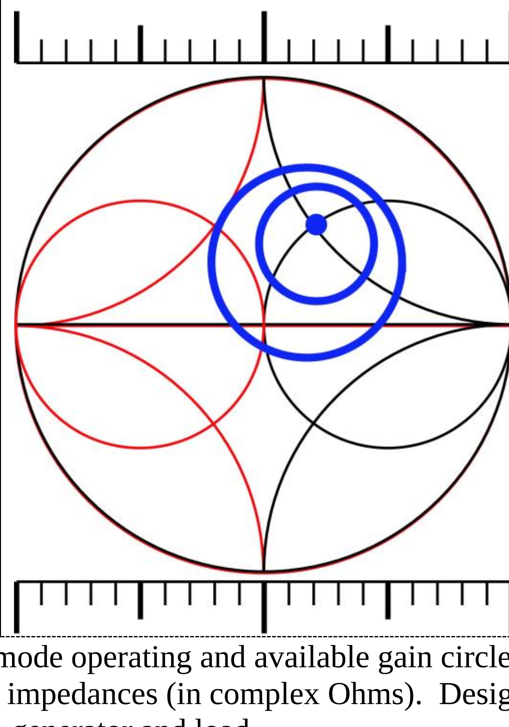
A MOSFET in common-source mode has $S_{11} = 0.3$ and S_{22}=0.5. Source and load stability circles are as shown. Draw **3*** circuit diagrams, giving resistor values, of methods of stabilizing the transistor.

Problem 4: The charts below use 50 Ohm normalization.

Available gain circles



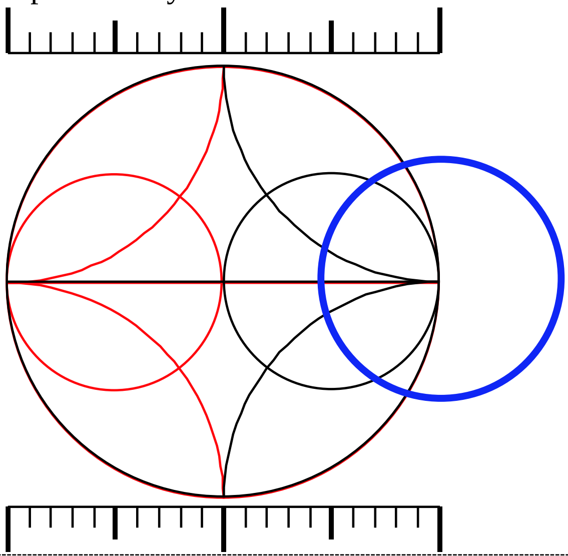
Operating gain circles



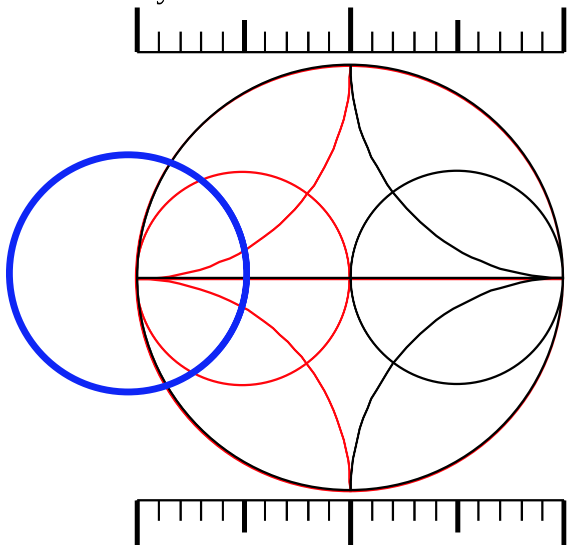
At 10 GHz, a MOSFET in common-source mode operating and available gain circles as shown. Find the optimum generator and load impedances (in complex Ohms). Design LC matching networks to match to a 50 Ohm generator and load.

Problem 5: The charts below use 50 Ohm normalization.

input stability circle



load stability circle



A FET in common-source configuration has the stability circles as shown above at 20 GHz. The magnitudes of both S11 and S22 are less than 1. Draw (two) circuit diagrams of two (different) stabilization methods for the transistor, giving required numerical element values. Use the scales above, along with a straight edge (edge of paper, a calculator, a book..) to aid you.

$$G_T = \frac{|S_{21}|^2 (1-|\Gamma_s|^2)(1-|\Gamma_L|^2)}{|(1-\Gamma_s S_{11})(1-\Gamma_L S_{22}) - S_{21}S_{12}\Gamma_s\Gamma_L|^2} \qquad G_P = \frac{1}{1-\Gamma_{in}{}^2}\cdot|S_{21}|^2\cdot\frac{1-|\Gamma_L|^2}{|1-\Gamma_L S_{22}|^2}$$

$$G_a = \frac{1-|\Gamma_S|^2}{|1-\Gamma_S S_{11}|^2}\cdot|S_{21}|^2\cdot\frac{1}{1-\Gamma_{out}{}^2} \qquad G_{\max} = \frac{|S_{21}|}{|S_{12}|}\cdot\left[K-\sqrt{K^2-1}\right]\text{if } K>1$$

$$G_{MS} = \frac{|S_{21}|}{|S_{12}|}\cdot\text{if } K<1$$

$$K = \frac{1-|S_{11}|^2-|S_{22}|^2+|\Delta|^2}{2|S_{21}S_{12}|} \quad \text{where } \Delta = \det[S]$$