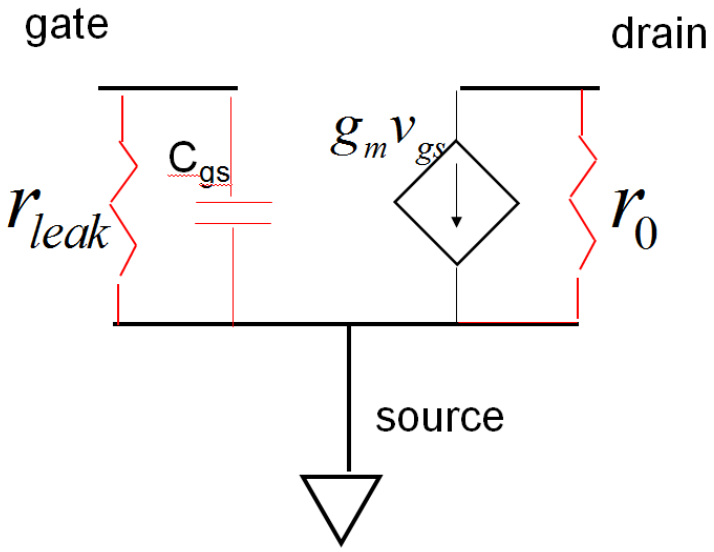
EECS 277A HW 3

Problem 1: Textbook 4.5

Problem 2: Textbook 4.6

Problem 3: RF-CMOS: Sometimes in a TFT, the gate is "leaky". We model that as a leakage resistance from gate to source below. For this small-signal circuit, find the Y-matrix and the cutoff frequency f_T and the f_{max}. Recall that f_T is the frequency at which the current gain h_{21} drops to unity, and f_{max} is the frequency at which Mason's unilateral power gain "U" drops to unity. (The f_{max} is a trick question. Why?) Assume r_{leak} is large.



Problem 5: Text 5.3

Problem 6: Text 5.4

Problem 7: Text 5.7

Problem 8: Text 5.11

Appendix (Next page) contains useful formulas for y matrix to h matrix conversion:

$$U = \frac{|y_{21} - y_{12}|^2}{4[\mathrm{Re}(y_{11}) \cdot \mathrm{Re}(y_{22}) - \mathrm{Re}(y_{12}) \cdot \mathrm{Re}(y_{21})]}$$

$z' = z/R_o$. $y' = yR_o$. $h_{11}' = h_{11}/R_o$; $h_{12}' = h_{12}$; $h_{21}' = h_{21}$; $h_{22}' = h_{22}R_o$.

$s_{11} = \dfrac{(z_{11}' - 1)(z_{22}' + 1) - z_{12}' \cdot z_{21}'}{(z_{11}' + 1)(z_{22}' + 1) - z_{12}' \cdot z_{21}'}$	$y_{11}' = \dfrac{(1 - s_{11})(1 + s_{22}) + s_{12} \cdot s_{21}}{(1 + s_{11})(1 + s_{22}) - s_{12} \cdot s_{21}}$	$z_{11}' = \dfrac{(1 + s_{11})(1 - s_{22}) + s_{12} \cdot s_{21}}{(1 - s_{11})(1 - s_{22}) - s_{12} \cdot s_{21}}$	$h_{11}' = \dfrac{(1 + s_{11})(1 + s_{22}) - s_{12} \cdot s_{21}}{(1 - s_{11})(1 + s_{22}) + s_{12} \cdot s_{21}}$
$s_{12} = \dfrac{2z_{12}'}{(z_{11}' + 1)(z_{22}' + 1) - z_{12}' \cdot z_{21}'}$	$y_{12}' = \dfrac{-2s_{12}}{(1 + s_{11})(1 + s_{22}) - s_{12} \cdot s_{21}}$	$z_{12}' = \dfrac{2s_{12}}{(1 - s_{11})(1 - s_{22}) - s_{12} \cdot s_{21}}$	$h_{12}' = \dfrac{2s_{12}}{(1 - s_{11})(1 + s_{22}) + s_{12} \cdot s_{21}}$
$s_{21} = \dfrac{2z_{21}'}{(z_{11}' + 1)(z_{22}' + 1) - z_{12}' \cdot z_{21}'}$	$y_{21}' = \dfrac{-2s_{21}}{(1 + s_{11})(1 + s_{22}) - s_{12} \cdot s_{21}}$	$z_{21}' = \dfrac{2s_{21}}{(1 - s_{11})(1 - s_{22}) - s_{12} \cdot s_{21}}$	$h_{21}' = \dfrac{2s_{21}}{(1 - s_{11})(1 + s_{22}) + s_{12} \cdot s_{21}}$
$s_{22} = \dfrac{(z_{11}' + 1)(z_{22}' - 1) - z_{12}' \cdot z_{21}'}{(z_{11}' + 1)(z_{22}' + 1) - z_{12}' \cdot z_{21}'}$	$y_{22}' = \dfrac{(1 + s_{11})(1 - s_{22}) + s_{12} \cdot s_{21}}{(1 + s_{11})(1 + s_{22}) - s_{12} \cdot s_{21}}$	$z_{22}' = \dfrac{(1 - s_{11})(1 + s_{22}) + s_{12} \cdot s_{21}}{(1 - s_{11})(1 - s_{22}) - s_{12} \cdot s_{21}}$	$h_{22}' = \dfrac{(1 - s_{11})(1 - s_{22}) - s_{12} \cdot s_{21}}{(1 - s_{11})(1 + s_{22}) + s_{12} \cdot s_{21}}$
$s_{11} = \dfrac{(1 - y_{11}')(1 + y_{22}') + y_{12}' \cdot y_{21}'}{(1 + y_{11}')(1 + y_{22}') - y_{12}' \cdot y_{21}'}$	$y_{11} = \dfrac{z_{22}}{z_{11}z_{22} - z_{21}z_{12}}$	$z_{11} = \dfrac{y_{22}}{y_{11}y_{22} - y_{21}y_{12}}$	$h_{11} = \dfrac{z_{11}z_{22} - z_{21}z_{12}}{z_{22}}$
$s_{12} = \dfrac{-2y_{12}'}{(1 + y_{11}')(1 + y_{22}') - y_{12}' \cdot y_{21}'}$	$y_{12} = \dfrac{-z_{12}}{z_{11}z_{22} - z_{21}z_{12}}$	$z_{12} = \dfrac{-y_{12}}{y_{11}y_{22} - y_{21}y_{12}}$	$h_{12} = \dfrac{z_{12}}{z_{22}}$
$s_{21} = \dfrac{-2y_{21}'}{(1 + y_{11}')(1 + y_{22}') - y_{12}' \cdot y_{21}'}$	$y_{21} = \dfrac{-z_{21}}{z_{11}z_{22} - z_{21}z_{12}}$	$z_{21} = \dfrac{-y_{21}}{y_{11}y_{22} - y_{21}y_{12}}$	$h_{21} = -\dfrac{z_{21}}{z_{22}}$
$s_{22} = \dfrac{(1 + y_{11}')(1 - y_{22}') + y_{12}' \cdot y_{21}'}{(1 + y_{11}')(1 + y_{22}') - y_{12}' \cdot y_{21}'}$	$y_{22} = \dfrac{z_{11}}{z_{11}z_{22} - z_{21}z_{12}}$	$z_{22} = \dfrac{y_{11}}{y_{11}y_{22} - y_{21}y_{12}}$	$h_{22} = \dfrac{1}{z_{22}}$
$s_{11} = \dfrac{(h_{11}' - 1)(1 + h_{22}') - h_{12}' \cdot h_{21}'}{(1 + h_{11}')(1 + h_{22}') - h_{12}' \cdot h_{21}'}$	$y_{11} = \dfrac{1}{h_{11}}$	$z_{11} = \dfrac{h_{11}h_{22} - h_{21}h_{12}}{h_{22}}$	$h_{11} = \dfrac{1}{y_{11}}$
$s_{12} = \dfrac{2h_{12}'}{(1 + h_{11}')(1 + h_{22}') - h_{12}' \cdot h_{21}'}$	$y_{12} = -\dfrac{h_{12}}{h_{11}}$	$z_{12} = \dfrac{h_{12}}{h_{22}}$	$h_{12} = -\dfrac{y_{12}}{y_{11}}$
$s_{21} = \dfrac{-2h_{21}'}{(1 + h_{11}')(1 + h_{22}') - h_{12}' \cdot h_{21}'}$	$y_{21} = \dfrac{h_{21}}{h_{11}}$	$z_{21} = -\dfrac{h_{21}}{h_{22}}$	$h_{21} = \dfrac{y_{21}}{y_{11}}$
$s_{22} = \dfrac{(1 + h_{11}')(1 - h_{22}') + h_{12}' \cdot h_{21}'}{(1 + h_{11}')(1 + h_{22}') - h_{12}' \cdot h_{21}'}$	$y_{22} = \dfrac{h_{11}h_{22} - h_{21}h_{12}}{h_{11}}$	$z_{22} = \dfrac{1}{h_{22}}$	$h_{22} = \dfrac{y_{11}y_{22} - y_{21}y_{12}}{y_{11}}$

FIGURE 4-17. Conversion table between the *s*-, *y*-, *z*-, and *h*-parameters.