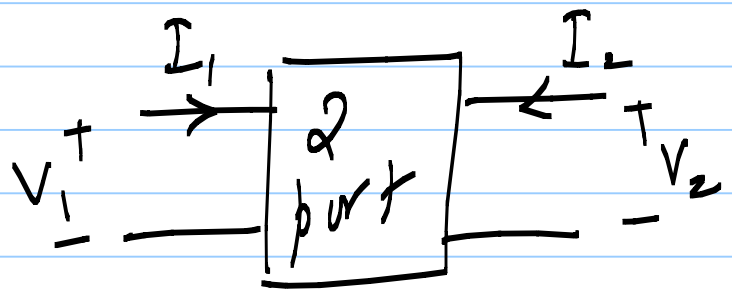
05/3/20

Lec 22

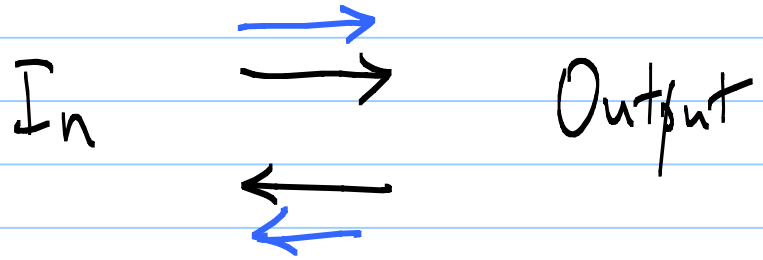
S-parameters

[Z], [Y], [a], [H]



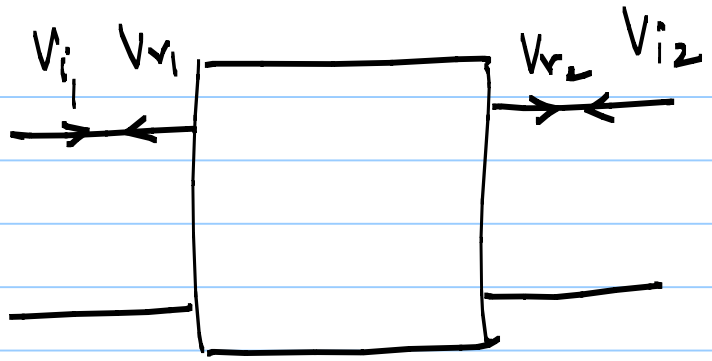
[ABCD]

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$



[S]

S-parameters



Normalisation factor of $\frac{1}{\sqrt{Z_0}}$

$$\begin{bmatrix} V_{r_1}/\sqrt{Z_0} \\ V_{r_2}/\sqrt{Z_0} \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} \begin{bmatrix} V_{i_1}/\sqrt{Z_0} \\ V_{i_2}/\sqrt{Z_0} \end{bmatrix}$$

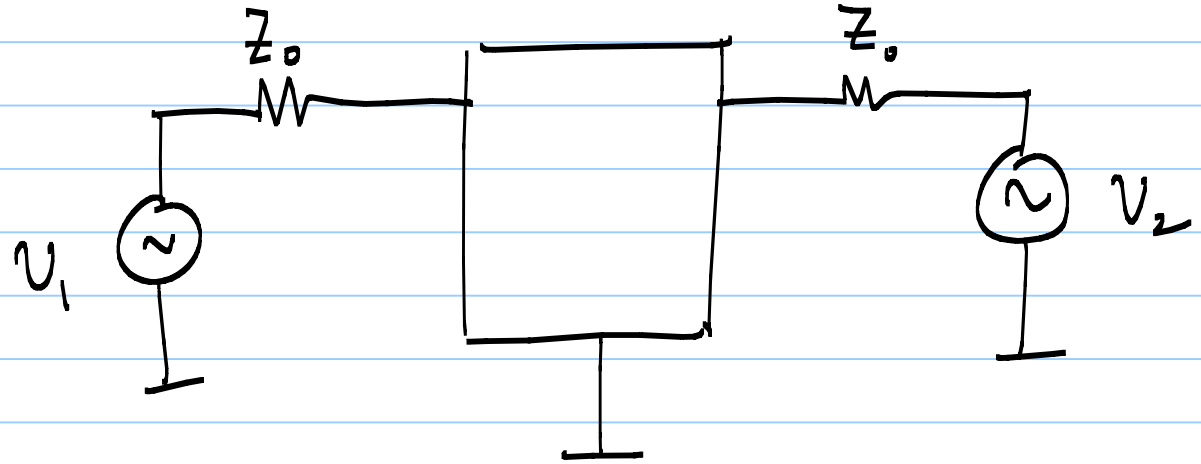
complex quantities $(x+jy)$

$$a_1 = V_{i_1}/\sqrt{Z_0} \; ; \quad a_2 = V_{i_2}/\sqrt{Z_0}$$

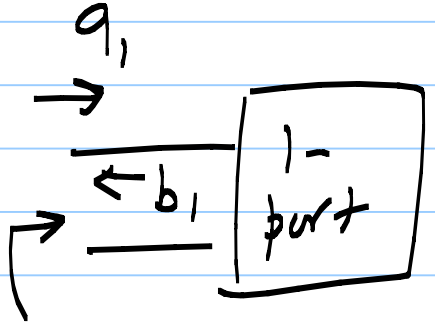
$$b_1 = V_{r_1}/\sqrt{Z_0} \; ; \quad b_2 = V_{r_2}/\sqrt{Z_0}$$

a_1^2 = incident power @ port 1 ...

$a_1^2, a_2^2, b_1^2, b_2^2$ — power quantities



1-port:



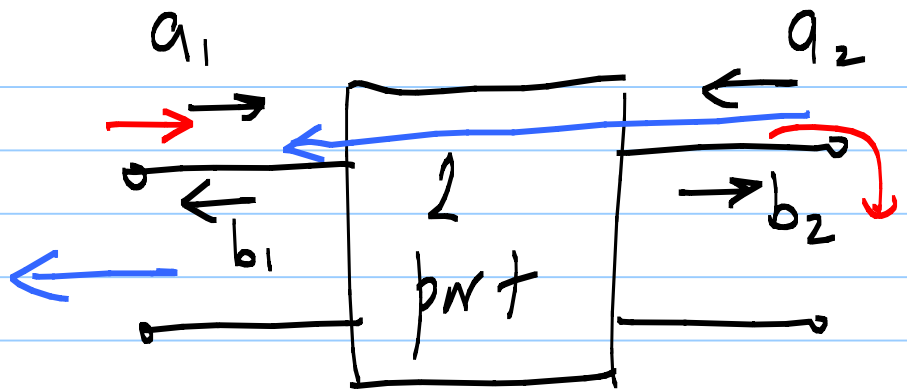
$\frac{b_1}{a_1} = S_{11} = \Gamma$

reflection coefficient

matched impedance: $Z_{in} = Z_0$

$\Gamma = 0$

$$|\Gamma| = \left| \frac{Z_{in} - Z_0}{Z_{in} + Z_0} \right|$$



If $S_{12} = 0$

$S_{11} = \frac{b_1}{a_1} =$ ⌜

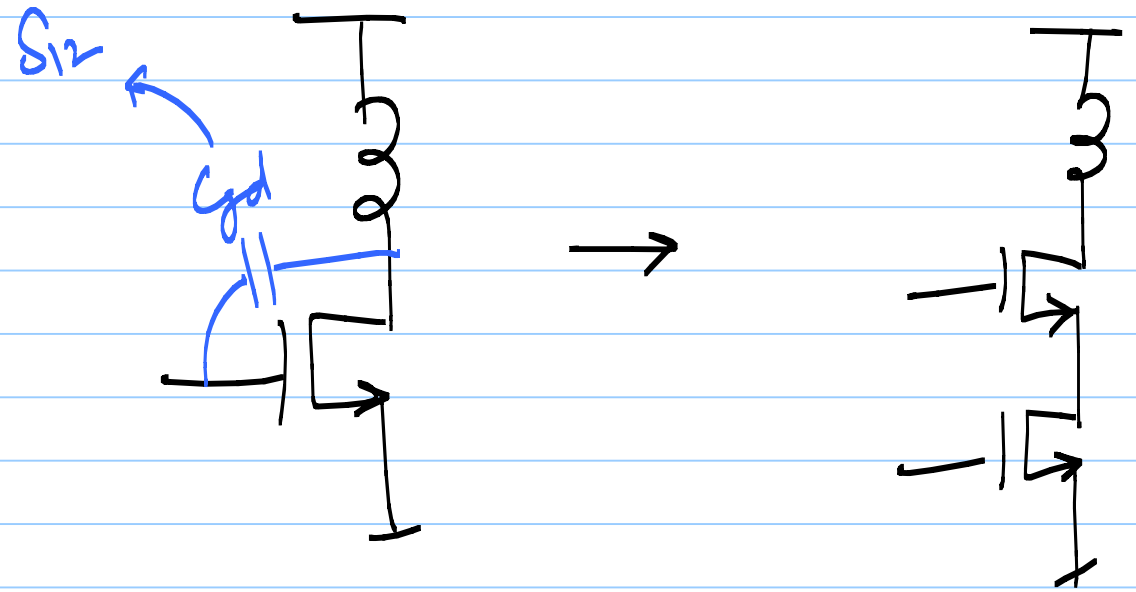
$b_1 = S_{11} a_1 + S_{12} a_2$

$b_2 = S_{21} a_1 + S_{22} a_2$

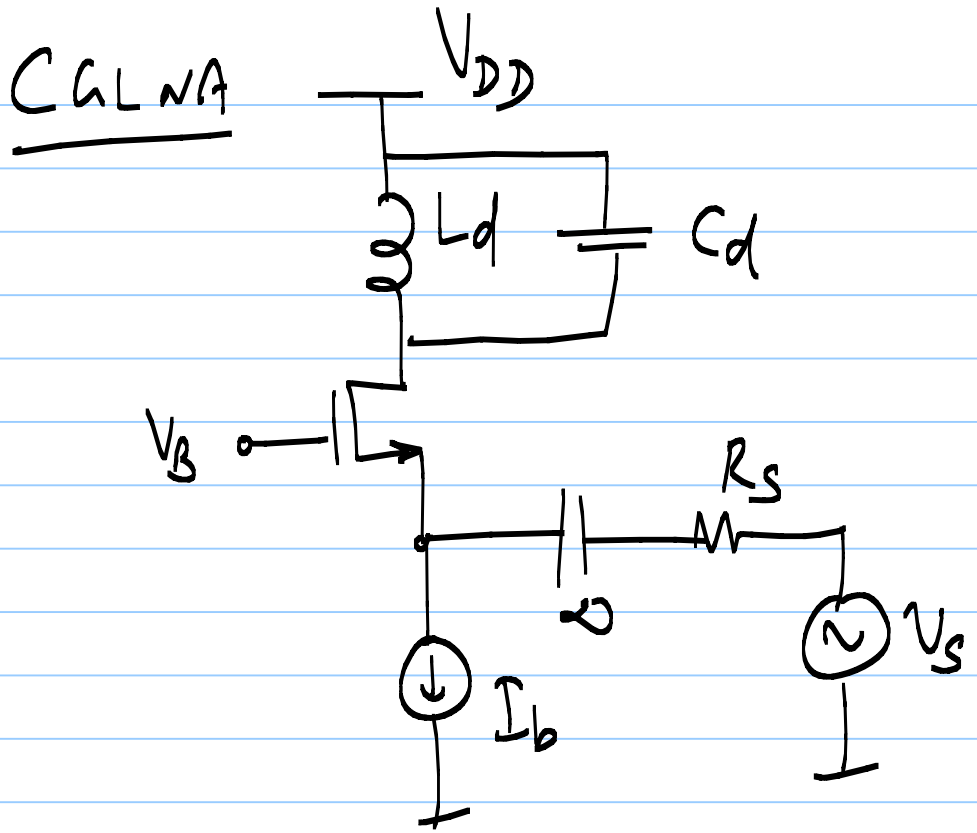
related to power gain

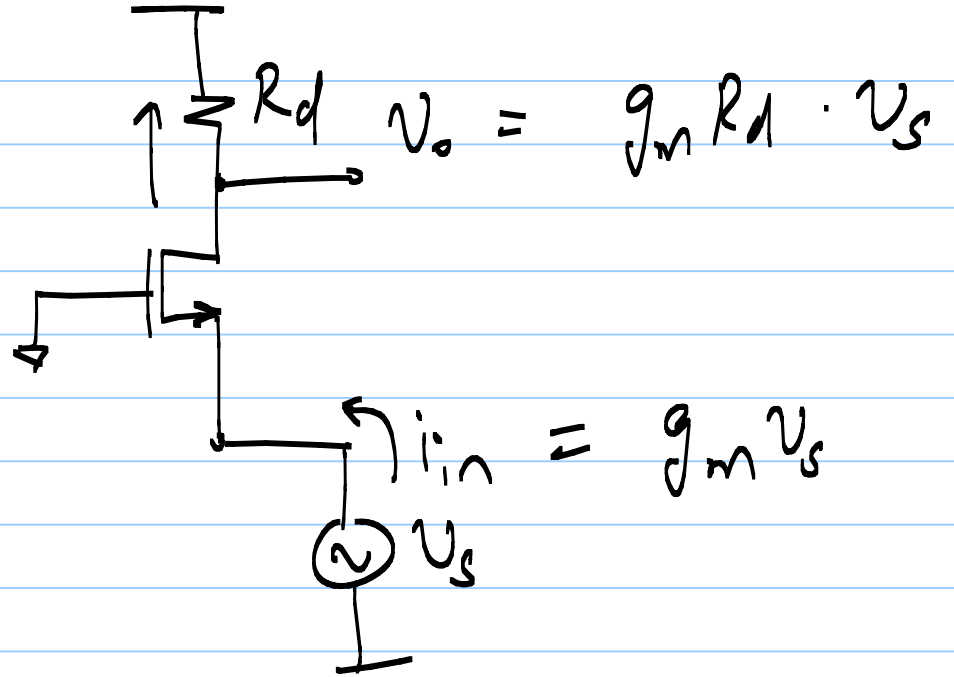
reverse transmission (affects stability in active systems)

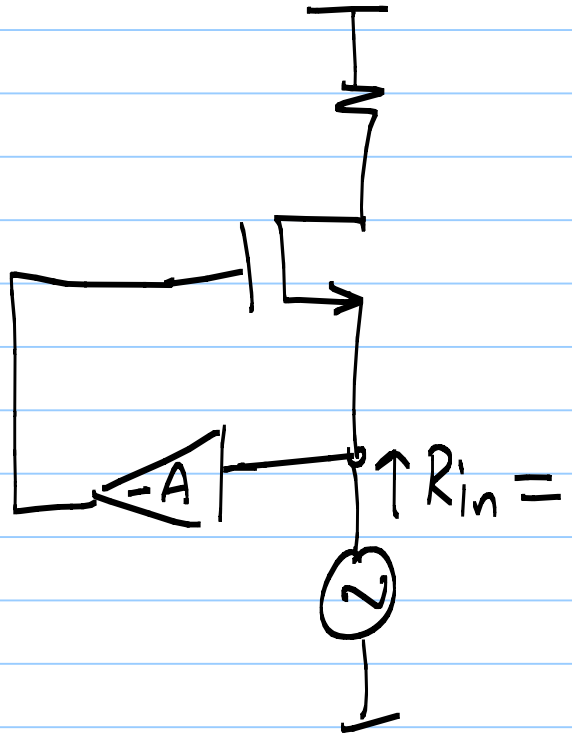
S_{11} & S_{22} decide whether input & output ports are matched to Z_0

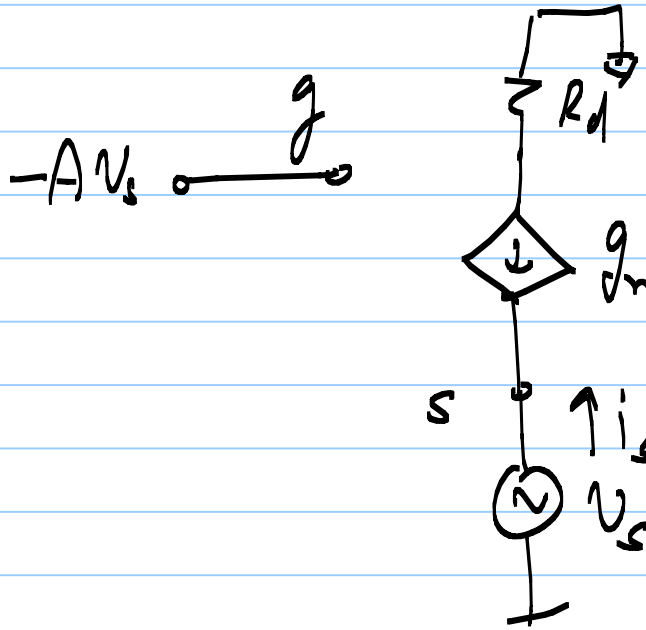

S_{12}
C_{gd}

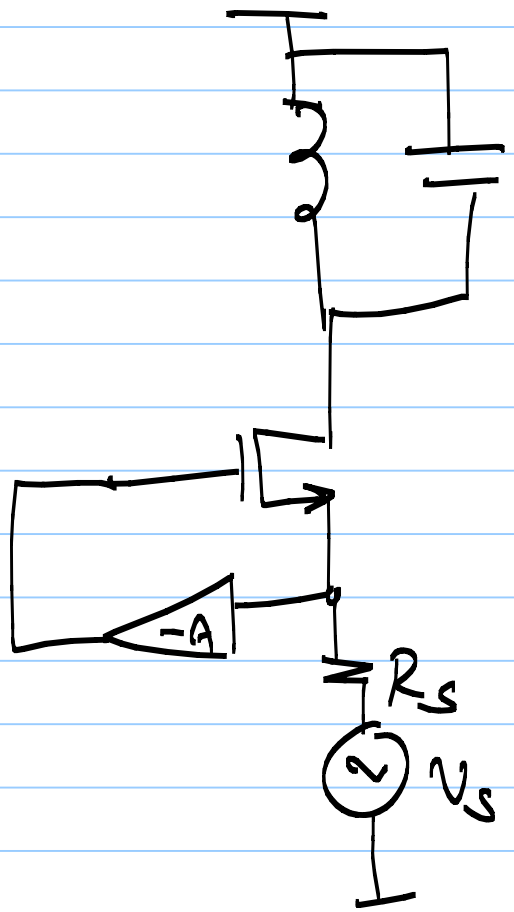
CGLNA




Rd
$v_o = g_m R_d \cdot v_s$
$i_{in} = g_m v_s$
v_s


-A
$R_{in} =$


$-Av_s$
g
R_d
$g_m v_{gs} = g_m(-Av_s - v_s)$
$= -(A+1) g_m \cdot v_s = -i_s$
s
i_s
v_s
$\frac{v_s}{i_s} = \frac{1}{g_m(A+1)}$



* Check for effect on
1) NF, 2) Noise of A
3) What does A look like

$$R_{in} = \frac{1}{(A+1)\,g_m}$$

e.g. $A = 1$

$$R_{in} = \frac{1}{2g_m}$$