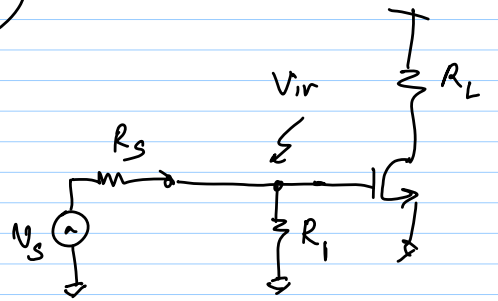
4-9-13

Lec 15

LNA topologies

* NF of LNA adds to overall NF
* Gain – neutralize noise of succeeding blocks
  - NF – divided by $A_{V_1}^2$ (available voltage gain)
  - IIP3 – divide by $\alpha_1^2 = (2A_{V_1})^2$
* @ Input – long PCB Trace
  - BSF between Antenna & LNA
  - match to 50Ω @ input

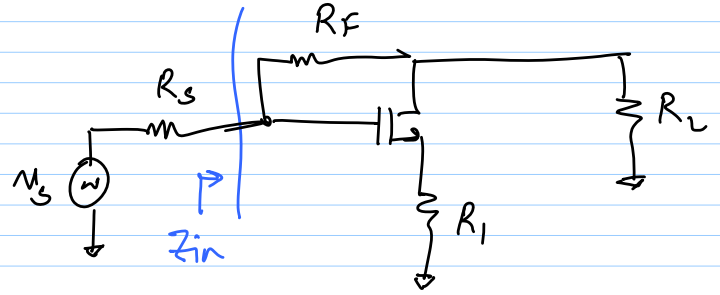
1) Resistor match with CS stage



* $R_1 = R_S$
* broadband match
* Attenuated signal $v_{in} = v_s/2$
* R_1 – thermal noise
* $F = 2 + \frac{4\gamma}{\alpha} \cdot \frac{1}{g_m R_S}$

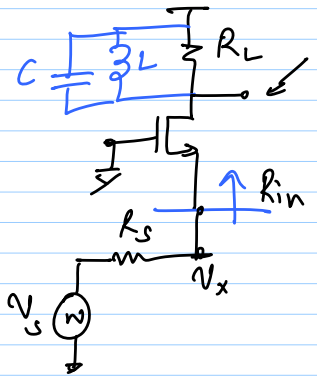
$NF_{min} = 3dB$

2) Shunt-series Amplifier



* No attenuation @ input
  Set $Re(Z_{in}) = R_S$
* $F >> F_{min}$

3) Common-gate amplifier



* $R_{in} = \frac{1}{g_m}$ $(r_{ds} >> R_L)$

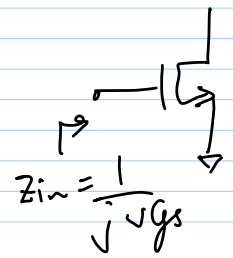
  $g_m = 20mS$ gives 50Ω matching
* gain $= \frac{g_m R_L}{2} = \frac{R_L}{2R_S}$
* $F = 1 + \gamma$ ← (HW) neglecting R_L noise
* $\boxed{F = 1 + \frac{\gamma}{\alpha} + \frac{4R_S}{R_L}}$

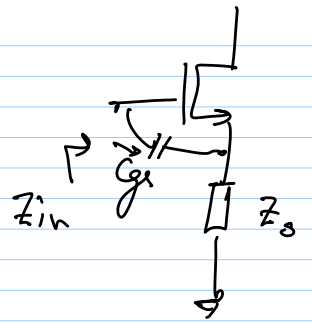
$\gamma = 0.67 \Rightarrow F_{min} = 1.67 \equiv 2.21\,dB$

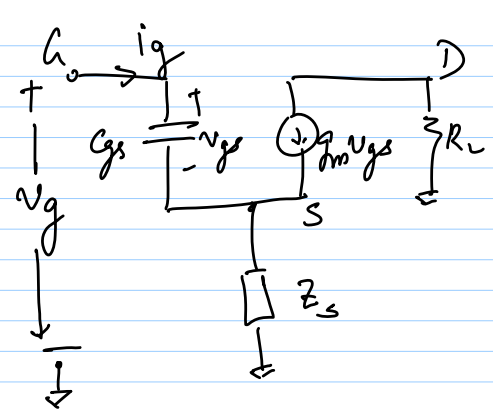
$$R_{in} = \frac{R_L + r_{ds}}{1 + g_m r_{ds}} \simeq \frac{1}{g_m} \text{ if } R_L << r_{ds}$$

* Cascoded CG — allows independent input matching

4) CS stage (narrowband)







$$\frac{v_g - v_{gs}}{Z_s} = g_m v_{gs} + i_g$$

$$\Rightarrow v_g = i_g Z_s + (1 + g_m Z_s) v_{gs}$$

$$v_{gs} = i_g / sC_{gs}$$

$$\Rightarrow v_g = i_g Z_s + (1 + g_m Z_s) \cdot \frac{i_g}{sC_{gs}}$$

$$\boxed{Z_{in} = \frac{v_g}{i_g} = Z_s + \frac{1}{sC_{gs}} + \frac{g_m Z_s}{sC_{gs}}}$$

a) $Z_s = R_0$

$$Z_{in} = R_0 + \frac{1 + g_m R_0}{sC_{gs}} \Big\} C_x$$