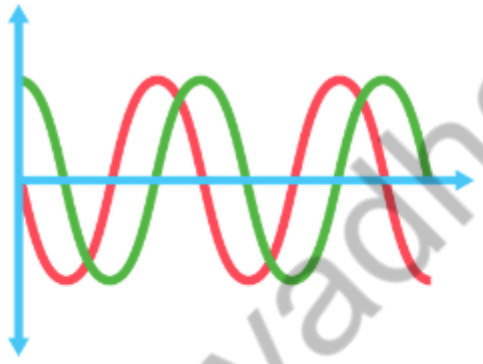
Course : RF Microelectronics

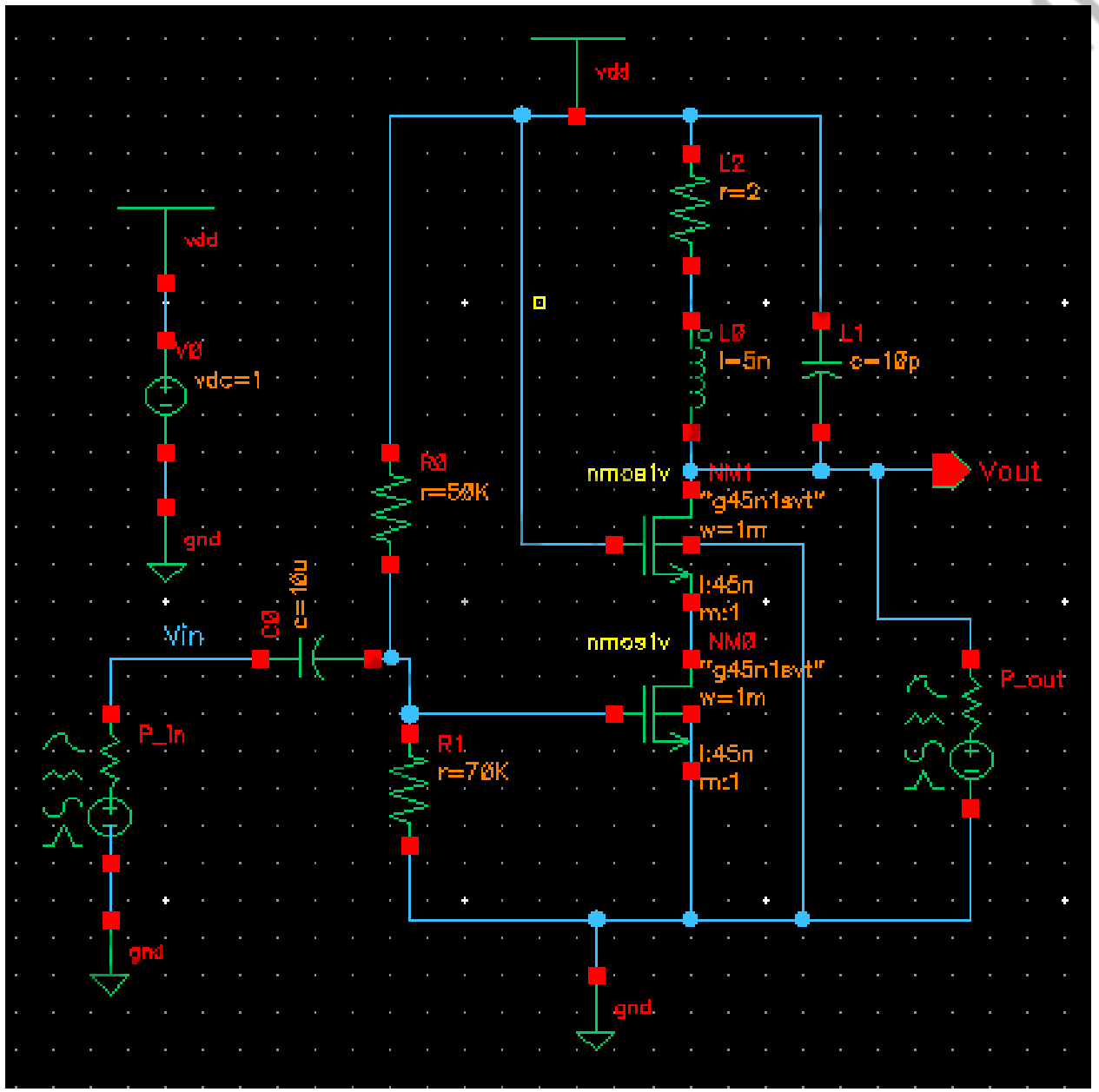


Lecture 3: Low Nosie Amplifiers

Prof. Sanjay Vidhyadharan

website: sanjayvidhyadharan.in

LNA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L0
l=5n
L1
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vdd
V0
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gnd
R0
r=50K
nmos1v
NM1
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w=1m
Vout
l:45n
m:1
C0
c=10u
Vin
nmos1v
NM0
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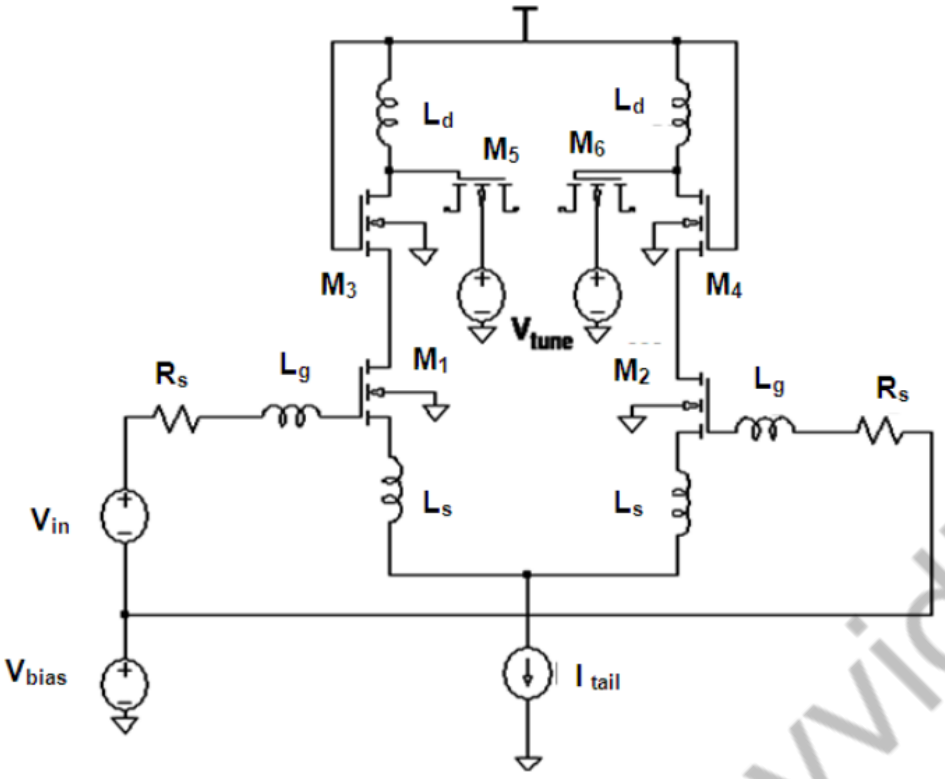
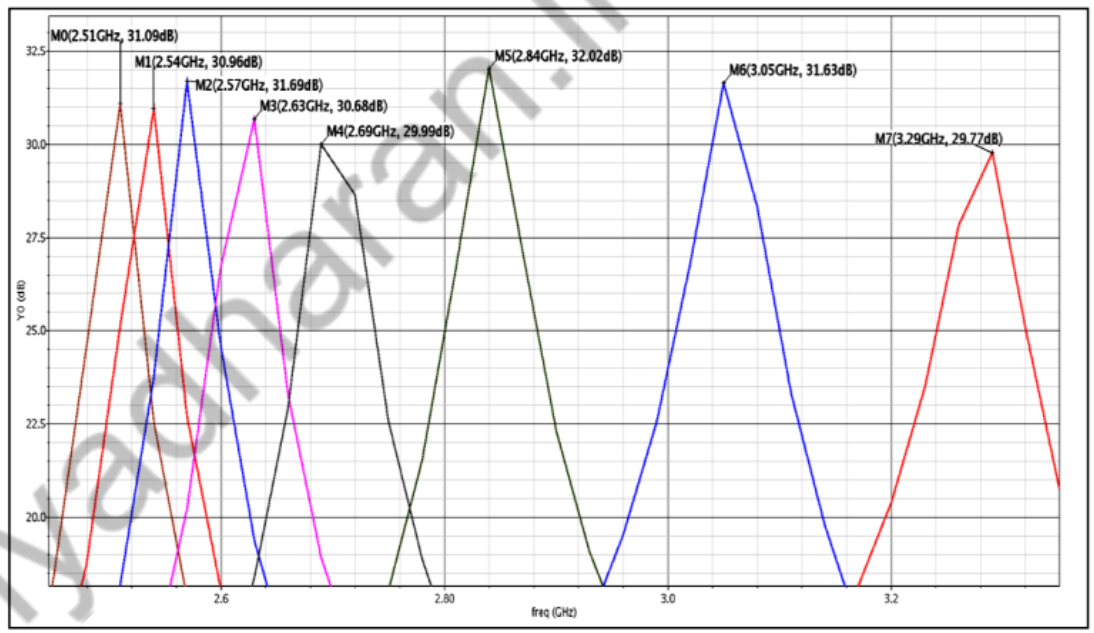
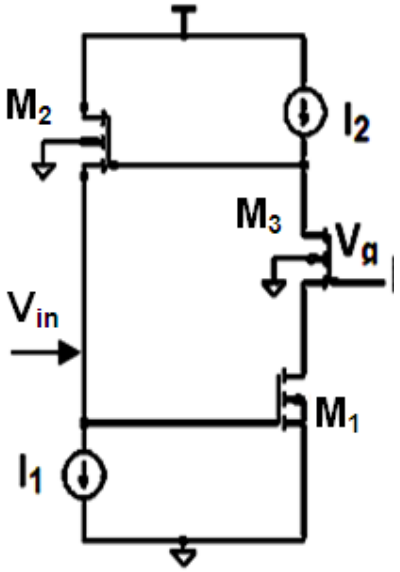
w=1m
P_out
P_in
R1
r=70K
l:45n
m:1
gnd
gnd
gnd

LNA



PMOS Varicap





Active Inductor

Figure of Merits

1. **AC gain , centre freq and bandwidth**
2. **Verification of gain with transient analysis**
3. **Nosie Figure**

https://sanjayvidhyadharan.in/courses/analog-ic-design/

• The amount of noise added by the network is embodied in the Noise Factor F, which is defined by

$$\text{Noise factor } F = \frac{\left(S/N\right)_{IN}}{\left(S/N\right)_{OUT}}$$

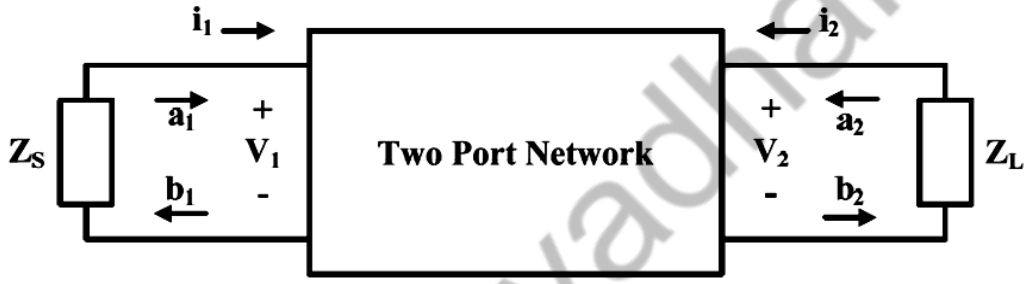
• F equals to 1 for noiseless network and in general F > 1. The noise figure in the noise factor quoted in dB

i.e. Noise Figure F dB = 10 log10 F $\quad F \geq 0$ dB

3 dB

Figure of Merits

4. S-Parameters



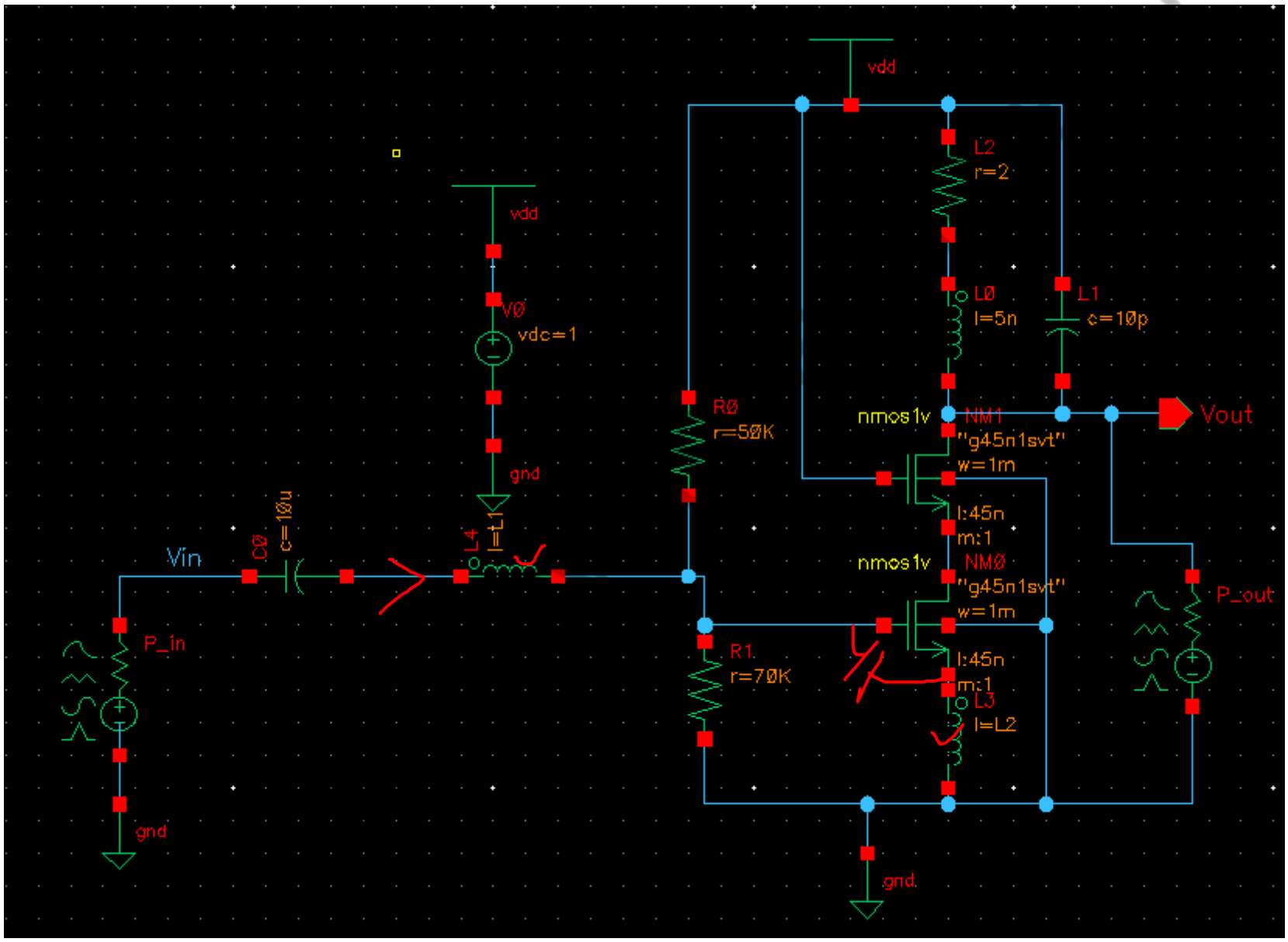
$S_{11} = b_1/a_1$ Network input reflection coefficient

$S_{21} = b_2/a_1$ Forward gain

$S_{22} = b_2/a_2$ Output reflection

$S_{12} = b_1/a_2$ Reverse gain

LNA



Design Steps for Input Matching

•**Step 1:** Chose a value below 10 nH for L_S (say 1 nH). Larger size spiral inductors in CMOS technology will be lossy and will occupy large silicon area.

•**Step 2:** Calculate ω_0 as per the formula given below for input impedance matching.

$$R_S = 50 = \omega_0 L_S$$

•**Step 3:** Calculate value of L_G as per the formula given below for desired value of Q (3dB band width BW_{3db}).

$$Q = \frac{f_0}{BW_{3dB}} = \frac{(L_G + L_S)\omega_0}{R_S}$$

•**Step 4:** Calculate C_{gs} as per the formula given below for obtaining the desired center frequency f_0.

$$f_0 = \frac{1}{2\pi\sqrt{C_{gs}(L_G + L_S)}}$$

•**Step 5:** Calculate the width W 3of the input stage transistor knowing C_{ox} from technology and assigning appropriate L. (say 500 nm to avoid short channel effects)

•**Step 6:** Calculate g_m and I_{tail} using the formulae given below.

$$g_m = \omega_T C_{gs} = \sqrt{2k_n'\left(\frac{W}{L}\right)_n I_{DS}}$$

Thankyou