Tutorial 2: LNA

Problem 1

It is preferred in current RF designs that the input of LNA be matched to 50-Ω. The easiest way is to shunt the gate with a resistor of 50-Ω.

a) Calculate the gain A_0, input impedance and noise figure (NF) in absence of gate noise. Assume that $R_{sh} = R_s$ and the resistances R_L and R_{sh} noiseless for NF derivation.

b) What are the disadvantages of shunt resistor with reference to gain and NF?

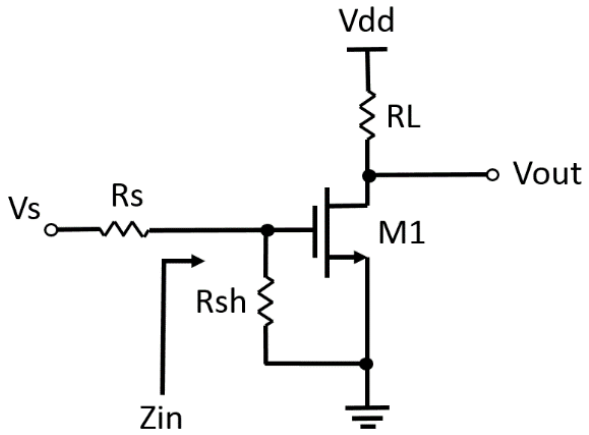


Fig. 1. Common-source amplifier with shunt input resistance

Problem 2

The inductor source degenerate amplifier shown below presents a noiseless resistance of 50-Ω for input power match.

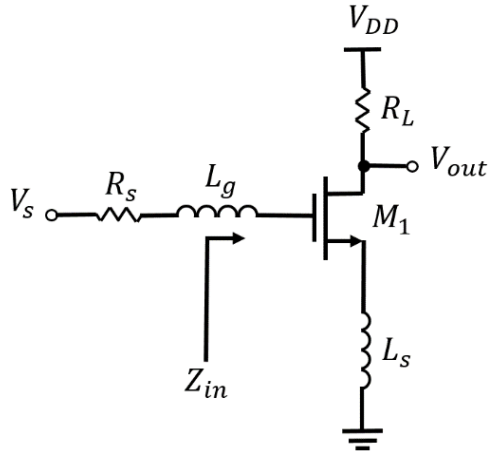


Fig. 2. Inductor source degenerated amplifier

a) Calculate the input impedance. How can we cancel the imaginary part of the complex input impedance so that the LNA presents 50-Ω real input resistance at input port? Neglect gate-drain, gate-bulk capacitance.

b) Calculate the NF. Neglect gate-drain, gate-bulk and gate-source capacitance.

c) C_{gd} bridges the input and the output ports. The reverse isolation of this LNA is very poor. Why is reverse isolation important? Suggest a modification to improve the reverse isolation.

Problem 3

A common-source low noise amplifier (LNA) with feedback is shown in the figure below. R_s is the input source resistance. Assume that the transistors are long-channel devices and $\lambda = 0$.

a) Determine the input impedance R_{in} of the LNA.

b) Calculate the voltage gain, $A_0 = {V_{out}}/{V_{in}}$ of the LNA after matching if $R_F = 10R_s$.

c) Derive an expression for the output noise contributed by R_s after matching. Assume $R_F \gg R_s$.

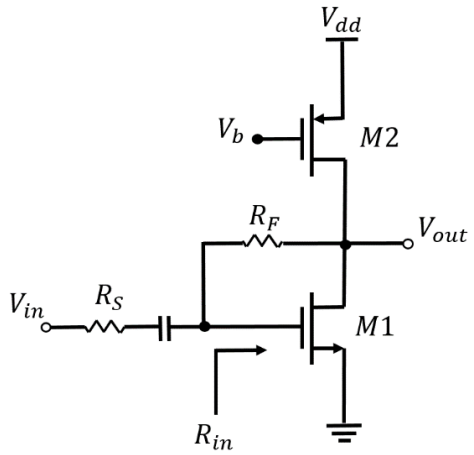


Fig. 3. CS stage with resistive feedback

Problem 4

In the common-source stage in Fig. 3, determine

a) Input impedance

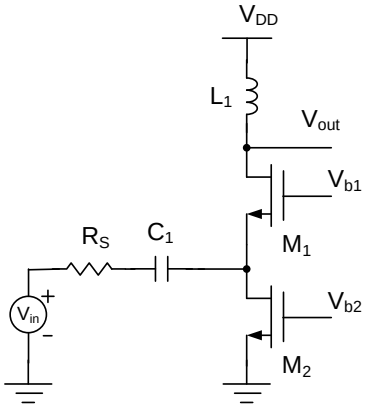
b) Closed-loop gain and

c) Noise Figure.

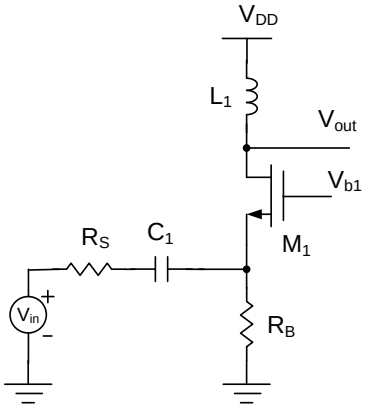
Assume $\lambda \neq 0$ and matching at the input.

Homework

Determine the noise figure of the common-gate (CG) circuits shown below. Neglect channel-length modulation and the body effect. Assume that R_1 is the loss of inductance L_1.



a)



b)