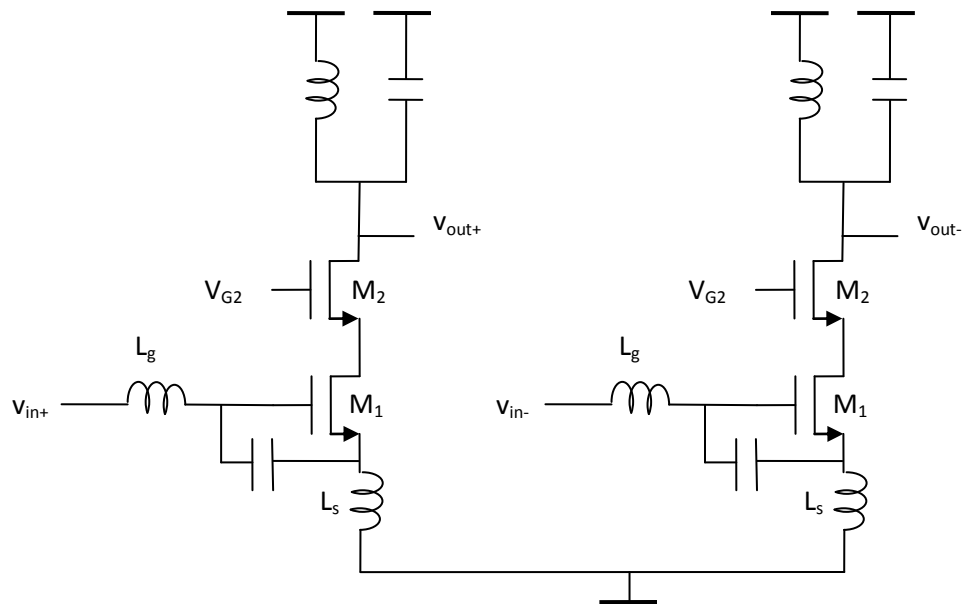


## Problems for exercise 5 (low noise amplifiers)

1. Problem 12.1 (solved by teacher)
2. Problem 12.5 (solved by the teacher)
3. Problem 12.7
4. Design problem on inductively source degenerated LNA:  
 An LNA for GPS (Global Positioning System) is to be designed. Since the signals received from the satellites are very weak, the noise must be low. The usual 130nm CMOS process is used with a 1.2V supply. Use the topology below:



**Given:** Frequency of operation  $f_0 = 1.575\text{GHz}$ , Source impedance  $R_S = 50\ \Omega$  (per side),

Load impedance  $R_L = 300\ \Omega$  (per side) at  $f_0$ , Length of transistors =  $0.3\ \mu\text{m}$

Assume inductors to be ideal and neglect noise from the cascode devices.

**Requirements:** Noise figure  $F < 1.5\text{dB}$ , Bias current  $< 5\text{mA}$  in total,

Voltage gain  $A_v = 26\text{dB}$  (input to output)

**Useful equations:**

$$Q = \frac{1}{2\omega_0 R_S C_{gs}} \quad R_{in} = R_S = \frac{g_m L_s}{C_{gs}} \quad \omega_0 = \frac{1}{\sqrt{(L_s + L_g) C_{gs}}}$$

$$A_v = 2Qg_m R_L \quad P = \frac{C_{gs}}{C_T} \quad \delta = 2\gamma = 4 \quad F = 1 + \frac{(\delta/5)(Q^2 + 1)P^2 + \gamma/4}{R_S Q^2 g_m}$$

**Hint:** Test Q=3 and P=1/3