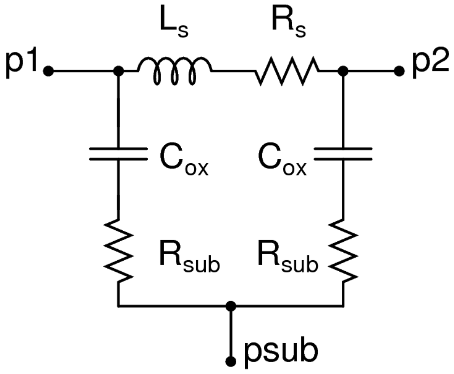
# EE6240 Design Project 1: LNA Design – due Friday 04/10/2013

In this project, you are asked to design a differential Low-Noise Amplifier (LNA) for the specifications given below. You are allowed to choose any reasonable circuit topology (including those not discussed in class). Use the IBM 90nm CMOS BSIM4 process parameters supplied to you through the class website. Design for the following specs:

- Frequency of operation $f_0$ = 2.3 to 2.6GHz
- Differential $R_{in}$ = 100Ω; S11 < -15dB between 2.3GHz to 2.6GHz. You can place an ideal balun from ahdlLib library between single-ended input port with impedance of 50Ω and differential input of LNA. Another option is to use an ideal transformer with appropriate turns ratio. Make sure to add an ideal attenuator at the output to compensate for the gain added by the ideal transformer, if any. Otherwise your gain and IIP3 numbers will be off.
- Voltage gain ≥ 20 dB over the complete band. Assume input capacitance of mixer is 100fF differential. Since your mixer in project 2 may have a different input capacitance, you will need to adjust your LNA output tuning accordingly at that time. Make sure you have some fixed capacitance in the LNA output tank for this purpose.
- NF ≤ 2dB. Extra drain thermal noise has already been modeled in the BSIM4 model file provided to you, with an effective $\gamma \approx 2$. It is assumed that induced gate noise is negligible, and it has not been modeled.
- $IIP_3 \geq$ -5dBm {Use two tones separated by 1MHz; choose the extrapolation point carefully}
- Minimise power consumption ($P_{diss}$); $V_{DD}$ = 1.2V

No ideal inductors are allowed! Download the scalable inductor model for cadence 6.0 from the class website, or implement your own inductor pi model based on the following figure and equations (check to make sure an inductor of a couple of nH has a Q of around 10 at 2.4GHz). All element values are in SI units.




$R_s = 1.5e9 \cdot L_s$

$C_{ox} = -0.0005e6 \cdot L_s^2 + 0.0312e\text{-}3 \cdot L_s + 0.0543e\text{-}12$

$R_{sub} = 0.0789e18 \cdot L_s^2 + 31.7071 + 3.4892e\text{-}9/L_s$