1. A differential negative-resistance VCO is shown below. The inductors have an inductance of 3nH and series resistance of 10Ω. Assume the bulks of the transistors are tied to their sources and the drain. Source diffusions are each 30µm². (This is basically the same design as last week)

(a) Assume Ibias = 2mA, what is the approximate amplitute of oscillation when Vc=0V. What is its frequency? Confirm with transient simulation.

(b) What is the approximate tuning range of the oscillator assuming Vc > 0 (what is the maximum Vc that will keep the varactor diodes from turning on)? What is the range in Kv? (Kv = \frac{dfrequency}{dVc}). Confirm the maximum frequency with transient simulation.

(c) Using Leeson’s derivation, what is the phase noise of the oscillator? Compare with a Pnoise simulation... looking at the noise summary, what is missing from your estimate?

(d) What is the effect of noise injection on Vc? Specifically, if a 1mV, 1MHz sinewave is injected at Vc, what power will you see at 1MHz offset? Check with PAC simulation. Predict the effect of putting a 1kΩ resistor in series with Vc.

VTO=0.4V  KP=200µA/V²  GAMMA=0.6  Phi=0.6  LAMBDA=0.15
CJ=900µF/m²  PB=0.5V  TOX=7nm  CGSO=0.1nF/m  CGDO=0.1nF/m
Diode model:
CJO=400fF  VJ=0.6V  M=0.4  IS=5fA