

## EE6320 Homework 4: Due 11:59pm Wednesday 21/04/2021

1. A direct conversion receiver is shown in figure 1 below. The LNA has a gain of  $A_1$  and Noise Factor  $F_1$ ; each of the I and Q mixers has high input impedance and input-referred noise voltage  $\overline{v_n}$ . Assume that the noise of the LPF is negligible. If the I and Q outputs are simply added, determine the over noise figure in terms of block noise figures.
2. A cross coupled oscillator can be re-drawn as two tuned amplifiers placed in a feedback loop as shown in figure 2 below. If the two inductors exhibit a mismatch of  $\Delta L$ , determine the oscillation frequency by calculating the frequency at which the total phase shift around the loop reaches  $360^\circ$ .
3. A common-source amplifier stage is loaded by a parallel RLC tank. Prove that the Quality Factor [ $Q = (\omega_0/2) \cdot (d\phi/d\omega)$ ] is equal to  $R_p/(L\omega_0)$ .

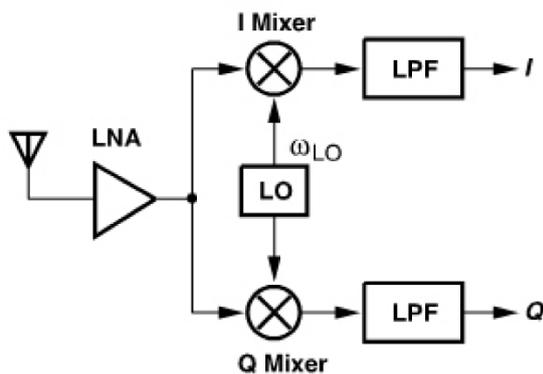


Figure 1

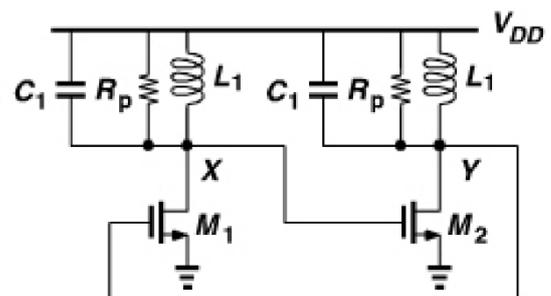


Figure 2