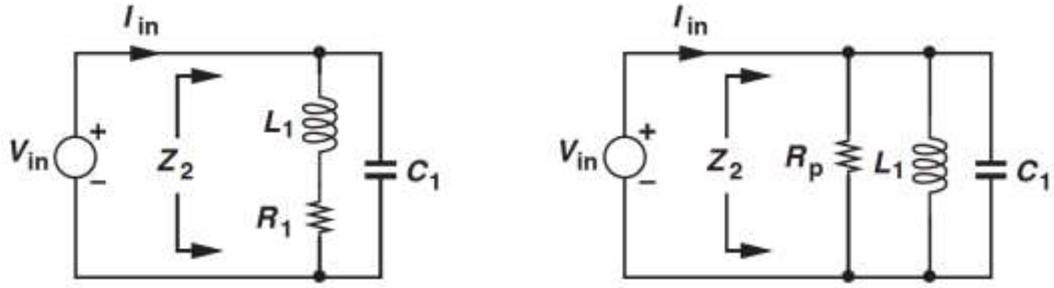
EHB 335E HW#6

No due date – **For final exam preparation.**

1) In this problem, you will analyze how the tank in Fig. 1(a) can be transformed to that in Fig. 1(b). Compute the impedance of each tank at a frequency $s = j\omega$ and equate the two impedances. Then, equate their real parts and do the same with their imaginary parts. Also, assume $j\omega L_1/R_1 \gg 1$, which means that the inductor has a high quality factor Q.) Determine the value of R_p.



(a) (b)

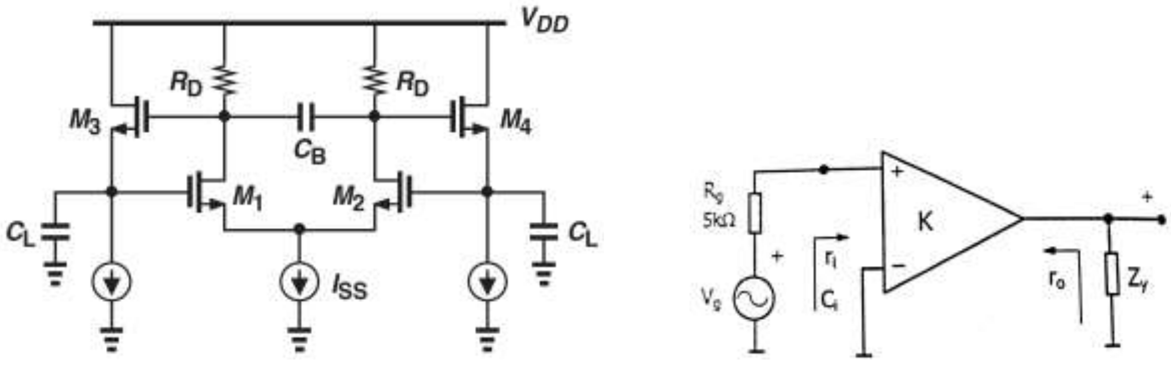
Fig. 1: Circuit diagrams for question 1.

2) A differential pair followed by source followers is placed in a negative-feedback loop as illustrated in Fig. 2(a). Consider only the capacitances shown in the circuit. Can this circuit oscillate? Explain.
Hint: Extract the half-circuit and find the number of individual poles.

3) Consider Fig. 2(a) again. Now, two resistors are inserted in series with the gates of M_1 and M_2. Taking into account C_{GS1} and C_{GS2} in addition to the other capacitors, explain whether the circuit can oscillate.

4) For the amplifier in Fig. 2(b), the unloaded voltage gain $A_{V,ul} = 100$, $r_i = 100k\Omega$, $C_i = 50pF$, and $r_o = 5k\Omega$. C_o is negligible. The load impedance Z_y is connected to the circuit, then the loaded voltage gain becomes $A_{V,l} = 70$, and the upper –3 dB cut-off frequency becomes 50 kHz. In order to increase the bandwidth of the circuit, how should an inductor L be added to the circuit (series or parallel), and what would be the value of this inductor?

5) Simulate the cross-coupled oscillator of Fig. 2(b) with $W/L = 10/0.18\,\mu m$, $I_{ss} = 5$ mA, $L_1 = 10$ nH. Place a resistance of $R_s = 10\,\Omega$ in series with each inductor (and exclude R_p) and add enough capacitance from X and Y to ground so as to obtain an oscillation frequency of 1 GHz. Plot the output voltages and the drain currents of M_1 and M_2 as a function of time. What is the minimum value of I_{ss} to sustain oscillation? Take $V_{DD} = 1.8$ V.



(a) (b)

Fig. 2: Circuit diagrams for questions (a) 2 and 3 (b) 4.