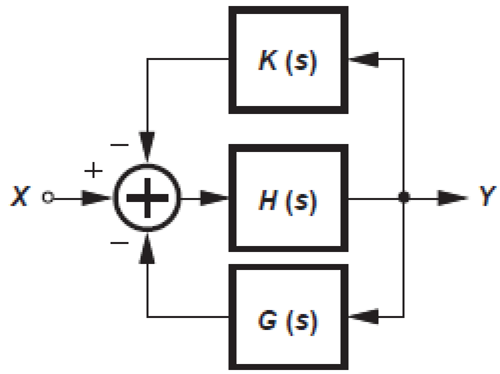
Problem Set #4: Oscillators

Oscillation Conditions:

Problem 13.2

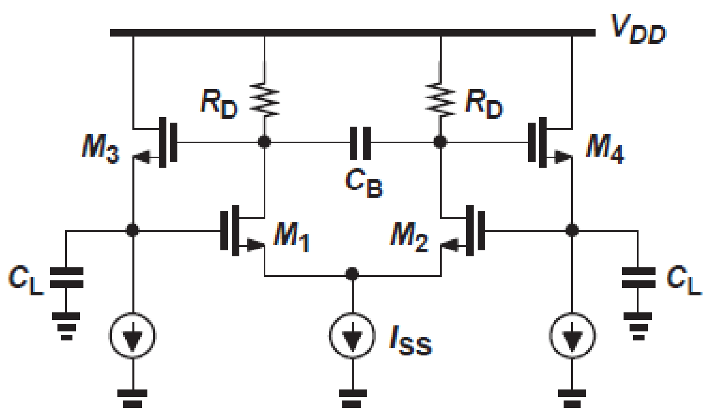
A negative-feedback system is shown. Under what conditions does the system oscillate?



Problem 13.6 & Problem 13.7

A differential pair followed by source followers is placed in a negative feedback loop as shown. Consider only the capacitances shown in the circuit. Can this circuit oscillate? Explain. Find the PM if $g_{m1}= g_{m2}$=1mS, $g_{m3}=g_{m4}$=10mS, R_D=10kΩ, C_B=0.5pF, C_L=2pF. What is the maximum C_L for a PM of 60^0?

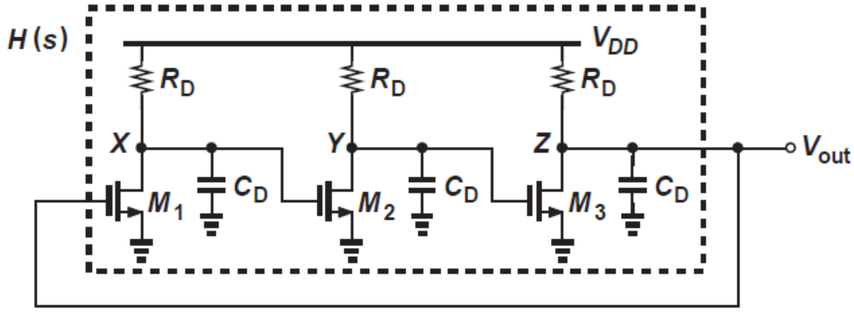
If two resistors R_s=10kΩ are inserted in series with the gates of M_1 and M_2. Taking into account C_{GS1} and C_{GS2} (=100fF) in addition to the other capacitors, find the PM for the same values given above.



Ring Oscillators:

Problem 13.8, Problem 13.9

Suppose in the ring oscillator shown, the value of R_D is doubled. How does oscillation frequency and startup condition change? Repeat if the value of C_D is doubled.

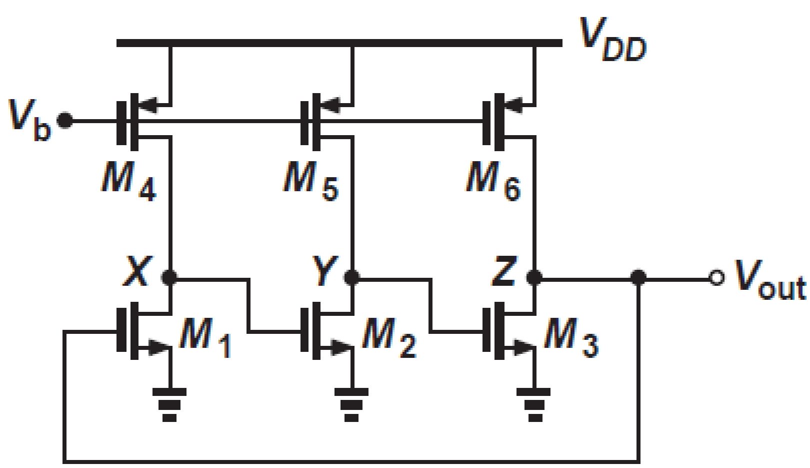


Problem 13.12

Derive the oscillation frequency and startup condition for the ring oscillator shown in the previous problem if the number of stages is increased to five.

Problem 13.13

Derive the oscillation frequency and startup condition for the ring oscillator shown. Consider only C_{GS} of the NMOS transistor and assume all transistors are in saturation with output resistance r_{on} and r_{op}.



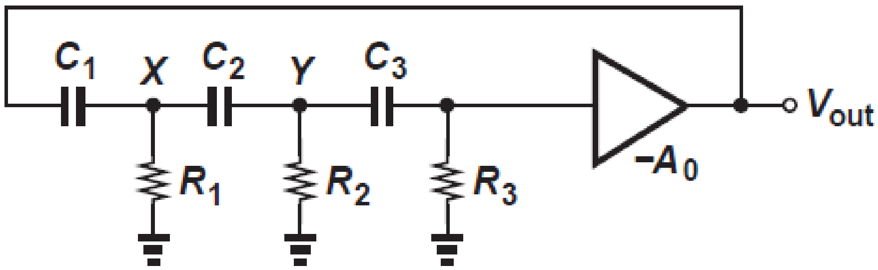
Problem 13.16

Draw the large-signal transient waveforms of the outputs of a five-stage CMOS ring oscillator.

Phase Shift and Wien-bridge Oscillators:

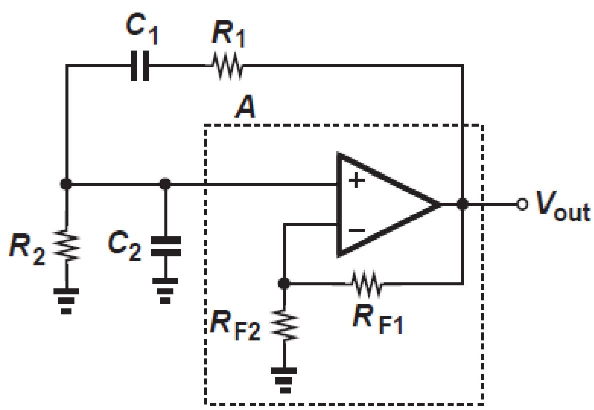
Problem 13.38

In the phase shift oscillator, $R_1=R_2=R_3=R$, and $C_1=C_2=C_3=C$, and $V_{out}=V_o\cos(\omega_0 t)$, where $\omega_0=1/(\sqrt{6}RC)$. Plot the waveforms at X and Y. Assume $A_0=29$.



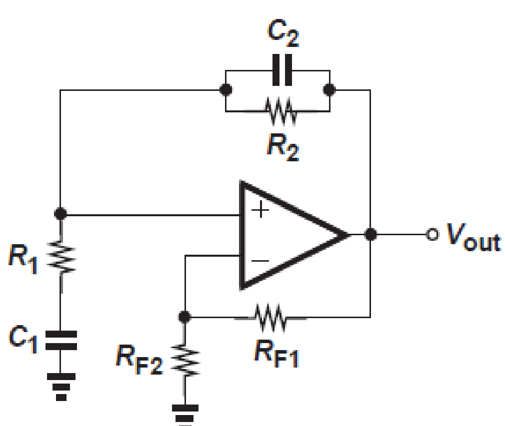
Problem 13.44

In the Wien-bridge oscillator, consider $R_1=R_2=R$, and $C_1=C_2=C$. If $V_{in}=V_o\cos(\omega_0 t)$, where $\omega_0=1/(RC)$, plot V_{out} as a function of time.



Problem 13.45

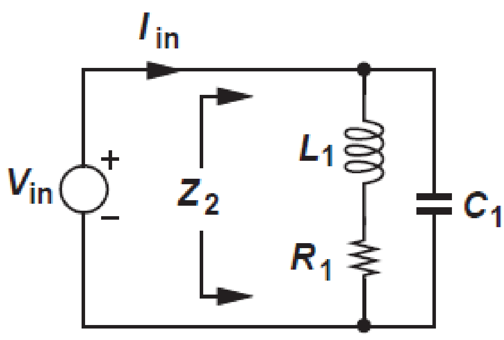
Can the modified Wien-bridge oscillator shown oscillate? Explain.



LC Oscillators:

Problem 13.23

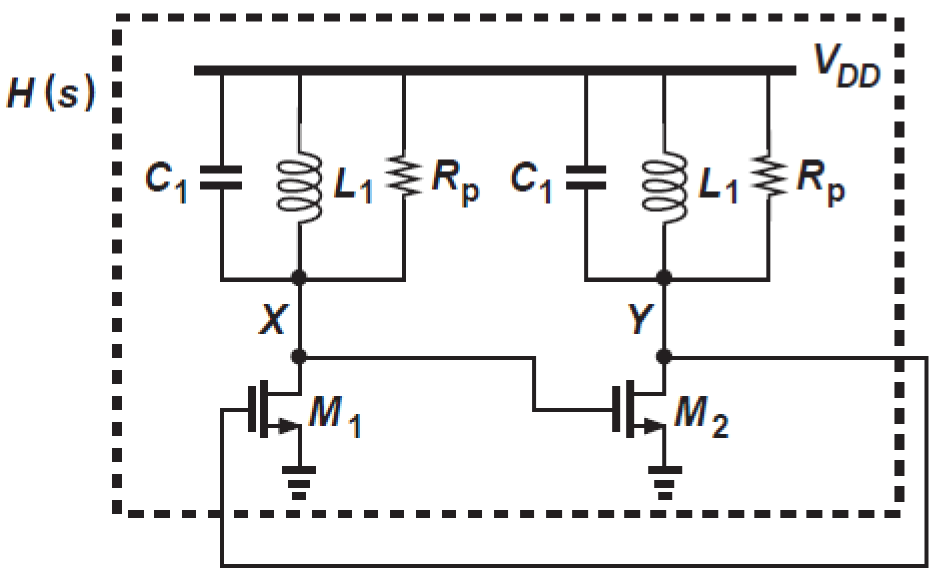
Compute the impedance of the two tanks in (a) and (b) at a frequency $s=j\omega$. Find the value of R_P to have equal impedances. Assume $L_1\omega/R_1 >> 1$ (i.e., the inductor has a high quality factor Q).



(a) (b)

Problem 13.29

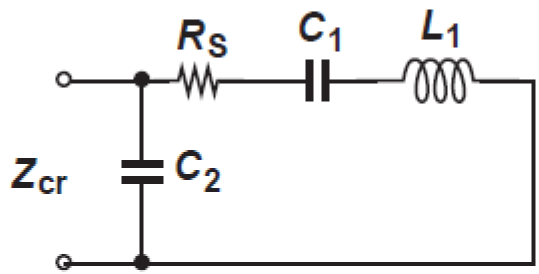
Suppose the LC oscillator shown is realized with ideal tanks, i.e., $R_P=\infty$. Taking channel-length modulation into account, determine the startup condition.



Crystal Oscillators:

Problem 13.59

(a) A crystal with a parallel resonance frequency of 10MHz has C_2=100pF and C_1=10fF. Determine the value of L_1.



(b) Suppose the crystal series resistance is equal to 5Ω. Design the oscillator shown for a frequency of 10MHz. Neglect the transistor capacitances and assume C_A=C_B=20pF, $(W/L)_2$=$2(W/L)_1$, and V_{DD}=1.2V.