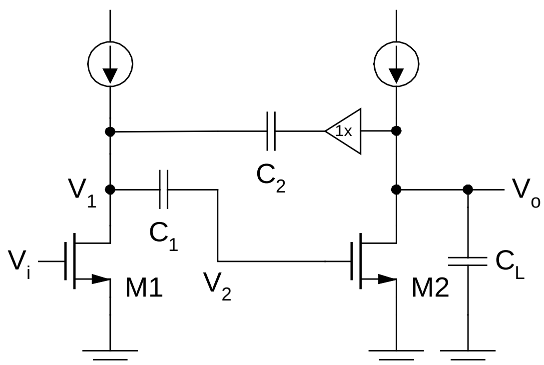
UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
and Computer Sciences

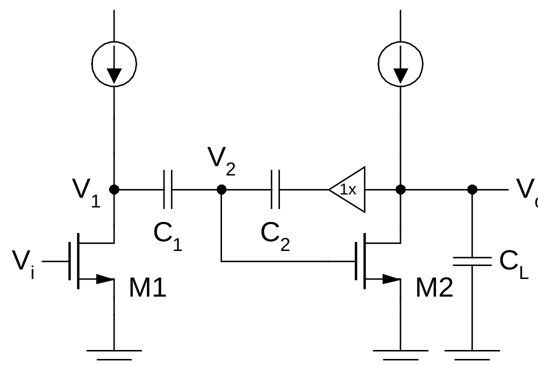
	Final Exam	**EECS 240**
B. E. BOSER	**May 17, 2000**	**SPRING 2000**

Show derivations and mark results with box around them. Erase or cross-out erroneous attempts. Mark your name and SID at the top of the exam sheet.

1. [30 points] All component values in the amplifiers below are identical except for g_{m2}, which is adjusted for 63 degrees phase margin with unity-gain feedback. Calculate the ratio of g_{m2} for amplifier A to g_{m2} for amplifier B as a function of C_{GS1}, C_{GS2}, C_1, C_2, C_L. Treat all non-given parameters as ideal.

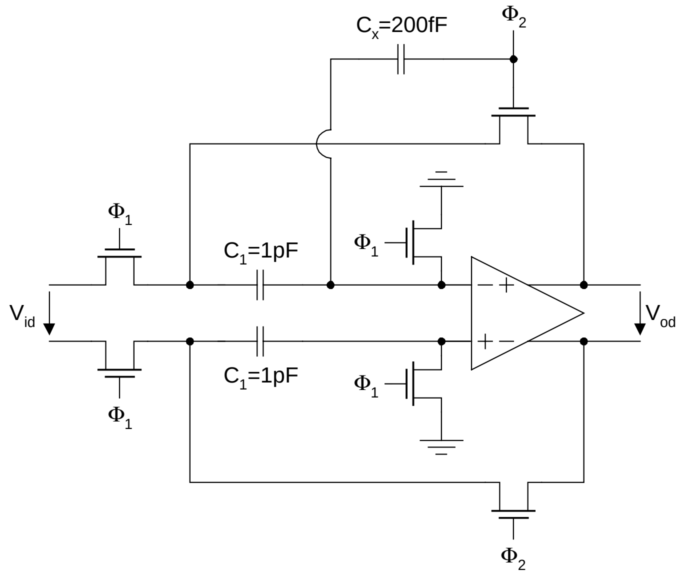


Amplifier A

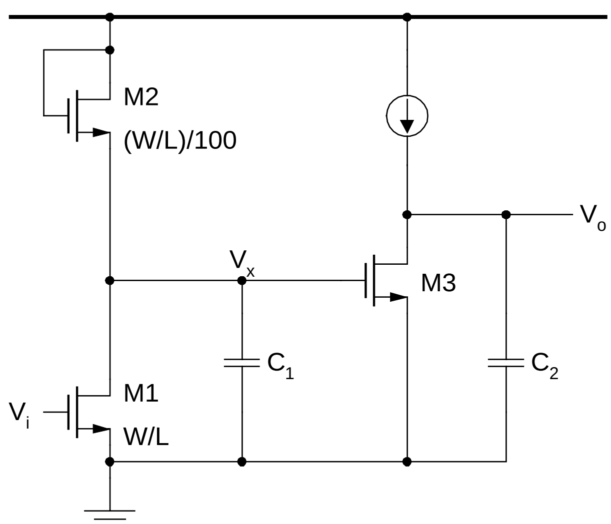


Amplifier B

2. [15 points] The circuit below is "perfectly" symmetrical except for capacitor C_x that was inadvertently added due to a layout error. Calculate V_{od} for V_{id}=0 just before the end of phase Φ_2. All transistors are NMOS, the amplifier is ideal, and Φ_1 and Φ_2 are 0V to 3V non-overlapping clocks.



3. [30 points] The amplifier below is placed in a negative unity-gain feedback loop (i.e. v_i=-v_o).
a) Calculate the total output noise delivered to C_2 in V-rms as a function of g_{m1}, g_{m3}, C_1, C_2. *Ignore the noise from M3*, flicker noise and all capacitors except C_1 and C_2. All devices operate in the forward-active region and $g_m r_o$>>1.
Note: M3 usually contributes more noise than M1 and M2 combined, but the math is a little too tedious to be appropriate for an exam: do only if you are done with all other problems.
b) Calculate the ratio g_{m1}/g_{m3} required for a 63-degree phase margin with unity-gain feedback.



4. [25 points] All transistors in the circuit below operate in the forward active region, have nominally the same W/L, and are biased at V_{dsat}=200mV (assume "square-law characteristics"). All devices are subject to the following random variations: σ_{VTH0}=2mV, $\sigma_{\Delta(W/L)/(W/L)}$ =0.2%, $\sigma_{\Delta R/R}$=0.5%, σ_{γ}=0.01$V^{1/2}$.
   Device Parameters: Φ_f=0.3V, $\lambda\rightarrow$infinity.
   a) Calculate the standard deviation of the input referred offset voltage, σ_{Vos} at low frequency for V_X=0V and V_X=3V. Assume that the mismatch is small compared to the mean for all parameters.
   b) Assuming σ_{Vos}=5mV (not the correct answer for part a), what is the fraction of amplifiers with an offset voltage less than 2mV?