

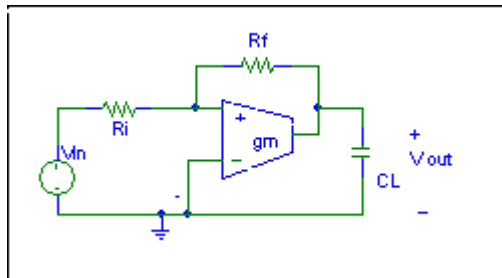
100 points, 2 hours, open book, open notes. Notebooks are due with the exam.

Good luck and have a good semester break

For the following assume $I_D = k(V_{GS} - V_{th})^2(1 + \lambda V_{DS})$

1. (40 points, 40 minutes)

For the following circuit find the voltage transfer function $v_{out}(s)/v_{in}(s)$



2. (20 points, 20 minutes)

Assume an NMOS transistor operating in saturation for which the input is a voltage applied at the source with respect to the bulk. In this case $g_{mb} = \partial I_D / \partial V_{sb}$ is needed as the transconductance parameter. Given that $V_{th} = V_{TO} + \gamma[(\phi + V_{sb})^{1/2} - (\phi)^{1/2}]$ determine g_{mb} .

3. (20 points, 15 minutes)

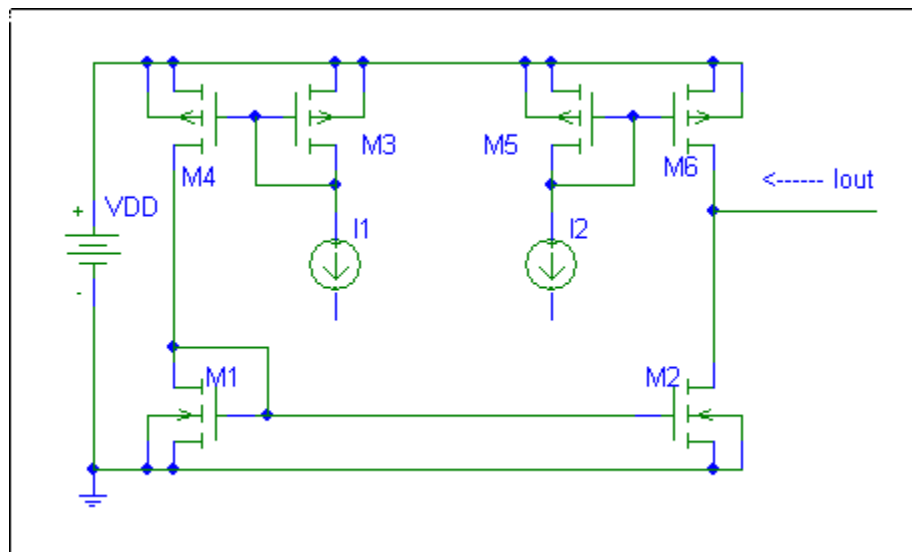
For the following circuit assume that each current mirror has a current gain $a = I_{out}/I_{in}$.

Also assume that I_1 and I_2 come from a differential pair with

$$I_1 = I_T / [1 + \exp(-v_{id}/V_T)]$$

$$I_2 = I_T / [1 + \exp(+v_{id}/V_T)]$$

Determine I_{out} and compare with that of the BJT OTA of $I_{out} = I_T \tanh(v_{id}/2V_T)$



4. (20 points., 15 minutes)

In the following pass transistor circuit, at $t=0$ switch U1 closes and U2 opens. E is large enough to place the transistor in saturation at $t=0$.

a) For $t > 0$ give the differential equation for the voltage V on the capacitor for the times at which the transistor remains in saturation. [include the effect of change in threshold voltage with V].

b) Find the V at which it remains constant.

