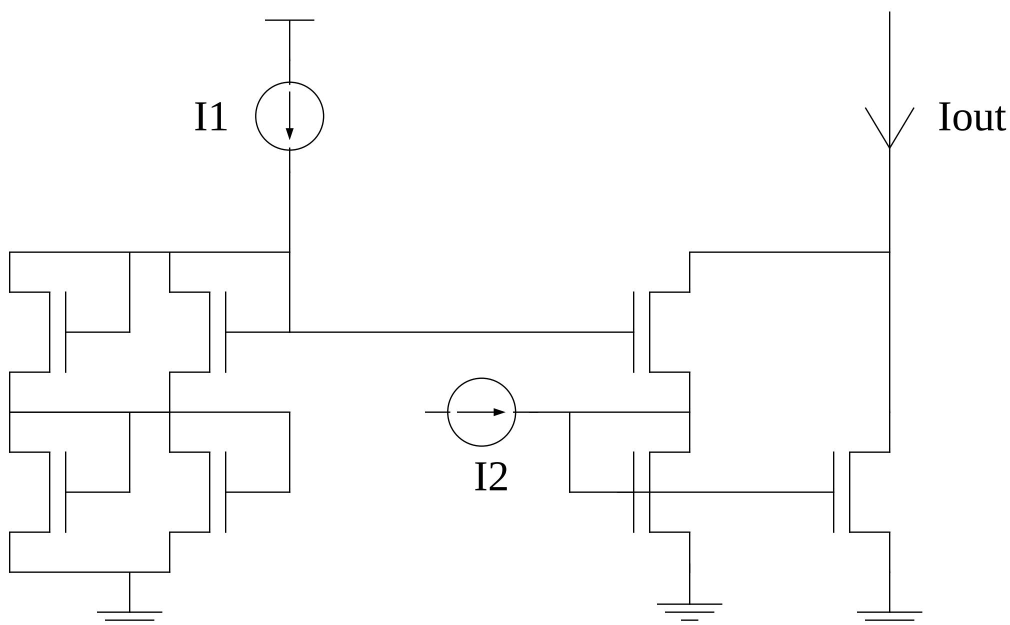
EEL 6935: HW#2

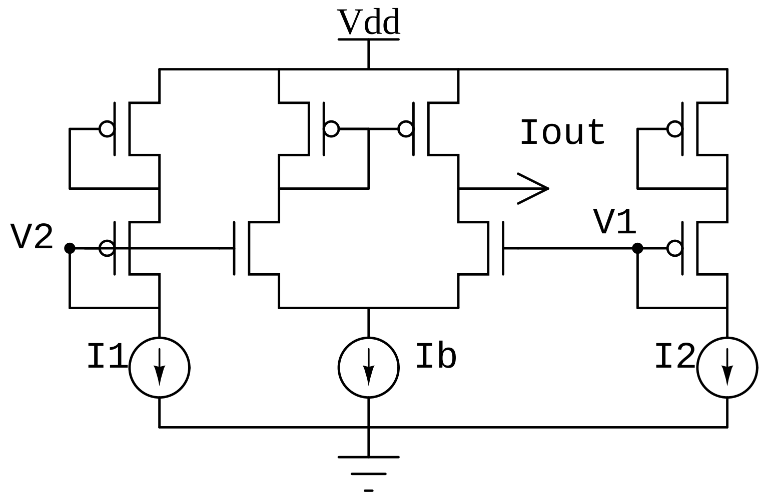
Due Wednesday, September 24, 2002 in class. Late homework loses $e^{\#\ of\ days\ late} - 1$ percentage points. See the current late penalty at http://www.cnel.ufl.edu/hybrid/harris/latepoints.html

For the first three problems, solve for I_{out} as a function of the inputs assuming subthreshold operation. Keep in mind that each circuit computes a very useful function. Assume $\kappa = 1$ and derive your answer. Show all of your work and explicitly state all assumptions, e.g. which transistors are in saturation, subthreshold operation, matching of devices, etc.

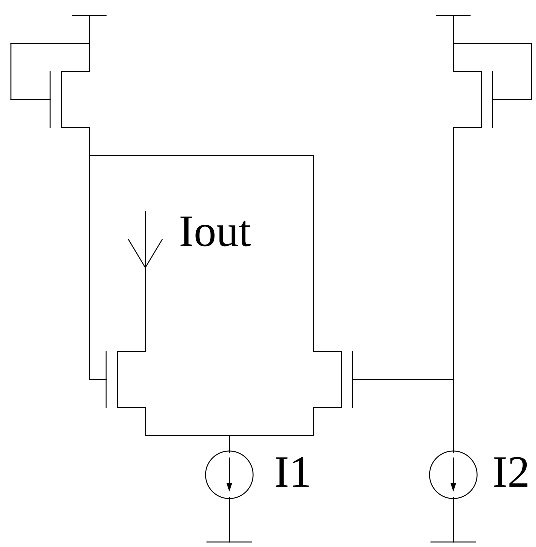
1. Solve for I_{out} as a function of I_1 and I_2 for the following translinear circuit. Note that I_2 can be positive or negative so make sure to describe the range of values of I_2 where your result is valid.



2. Solve the following circuit for I_{out} in terms of I_1, I_2, I_B, and any other circuit parameters you feel you might need. Make any reasonable assumptions but clearly state and justify them. Assume that $\kappa = 1$ for all devices. For full credit, you must simplify as much as possible (hint: there should be no *transcendental functions*[1] in the answer).



3. Solve for I_{out} as a function of I_1 and I_2. You will have to think a little bit more about this circuit than those previously worked on.



[1]A function which "transcends," (i.e., cannot be expressed in terms of) algebra.

For the final questions, you must have access to a circuit simulator. Examples include CADENCE SPECTRE, PSPICE, HSPICE, and winspice but use whichever simulator you feel comfortable with. Note that winspice is shareware that is available from www.winspice.com. We will be using the 0.6um AMI process available through MOSIS. Complete information about the process is available through
http://www.mosis.org/Technical/Processes/proc-ami-c5n.html
UF CADENCE users will already have this process available but other simulators may require the following model files available at
http://www.cnel.ufl.edu/hybrid/courses/EEL6935/nmos.txt
and
http://www.cnel.ufl.edu/hybrid/courses/EEL6935/pmos.txt

4. For a 6um x 6um nfet transistor, plot the Ids vs. Vgs curve for the device. Scan Vgs from 0 to Vdd. Calculate the approximate value of κ below threshold. Completely describe how you performed the calculation. Also, come up with a rule for defining what the threshold of the transistor is.

5. For a 6um x 6um nfet transistor, plot the Ids vs. Vds curve for the device for several below threshold values of Vgs. Calculate the approximate value of the Early Voltage V_E. Completely describe how you performed the calculation. Also, come up with a rule for defining what the saturation voltage is.

6. Verify your solution of Problem 3 for I_{out} as a function of I_1 and I_2. Show plots and compare your theoretical solution to your simulation results.