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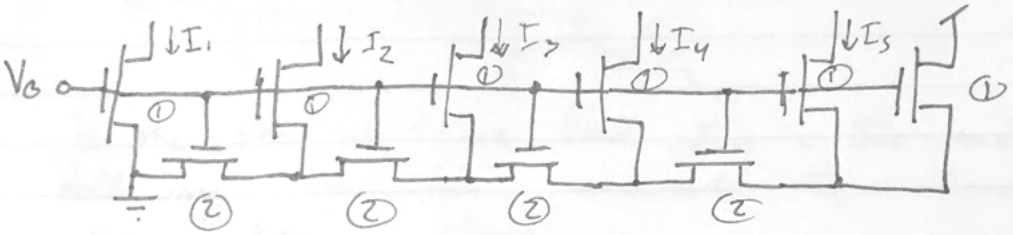
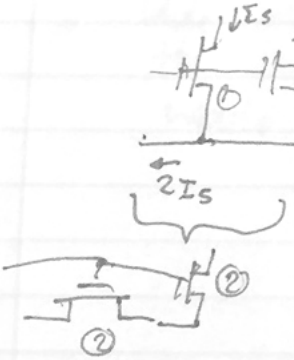
3.30.16

LAB 06: Series/Parallel MOS Networks and MOS Current Dividers

POST LAB:



Consider the ladder network of matched nMOS transistors, shown above, comprising some devices w/ a unit strength ratio and others with twice that strength ratio. In doing your analysis, you should assume that the output voltages are high enough to saturate that output transistors and that the Early effect is negligible. What relationship holds among output currents? Does this relationship depend on weak/moderate/strong inversion? Can ladder be extended to more outputs while maintaining the general relationship? Show how or explain why not.

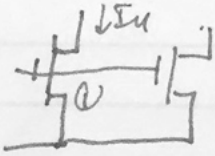


The two matched transistors w/ a strength ratio of 1 each in parallel on the far right are equivalent to a transistor with a strength ratio of 2.

Since the far two right in parallel are equivalent to a single transistor of strength 2,

The 3 far right transistors are equivalent to two transistors of strength 2 in series.

We saw from the pre-lab that 2 transistors of strength 2 in series are equivalent to one transistor of strength 1. This means the far right three transistors in the network are equivalent to a single transistor of strength 1.

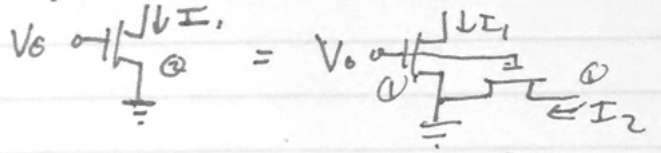


Now with this equivalent transistor, the far right is ~~equivalent to~~ the same as the first step of solving this problem.

Because $\frac{I_4}{I_{out}} = \frac{S_1}{S_1+S_2} = \frac{1}{2}$, we know $I_4 = I_5$.

These steps can be repeated until reaching the first transistor.

The entire ladder network is eventually equivalent to two parallel transistors of S=1, or one transistor of S=2



In the same way we find $I_4 = I_5$ and the following transistor network equivalences, we know that

$$I_1 = I_2 = I_3 = I_4 = I_5 \qquad I_{n+1} = I_n$$

This relation does not depend on whether transistors are in weak / moderate / strong inversion, because current models are following EKV equations which apply to all three.

This ladder could be extended to more outputs while maintaining the general relationship. If it followed the same pattern, the entire network would still be equivalent to