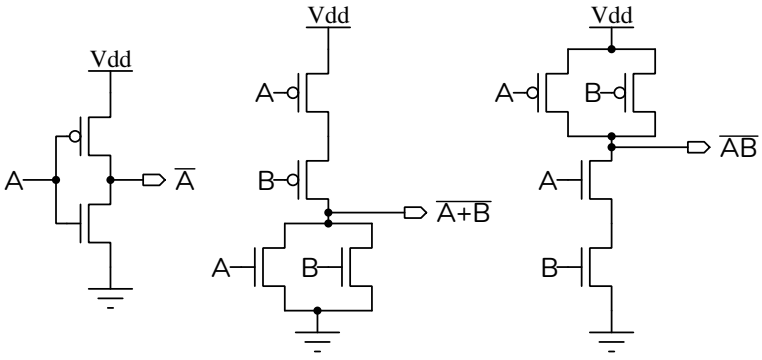
Implementation of Digital Logic Circuits

Exercise 1:



In which direction does the output current flow when the output is high? When it is low? Which transistors in the NAND circuit are on (conducting) in each case?

Exercise 2: A logic family has V_{OH}(min) = 5 V, V_{OL}(max) = 0.5 V, V_{IH}(min) = 4 V and V_{IL}(max) = 1.5 V. What are the noise margins?

Exercise 3: All else being equal, by how much would we expect to decrease power consumption when reducing logic levels from 5 V to 3.3 V? What would be the effect on power consumption in reducing the clock frequency from 50 MHz to 1 MHz?

Exercise 4: If a circuit draws $100\,\mathrm{mA}$ for $100\,\mu\mathrm{s}$ per second and draws $100\,\mu\mathrm{A}$ the rest of the time, how long will a $1000\,\mathrm{mAh}$ battery last?

Exercise 5: 18650 cells weigh about 50 g, output 3.7 V and have a capacity of 3500 mA-h. How many cells are needed to build an 85 kWh EV battery? How much does it weigh?

Exercise 6: What are the active-state current and the RC time constant for a wired-or interrupt-request line using a 10kΩ resistor pulling up a circuit with 50 pF capacitance to 3.3 V?

Exercise 7: The Apple M3 CPU has an area of approximately $146\ \text{mm}^2$. How many die fit on one 300 mm wafer? If each wafer costs $20,000 to manufacture, what is the cost per die?

Exercise 8: How many square mm of PCB area does each package require? Which packages have their pins accessible when the package is placed on the PCB?