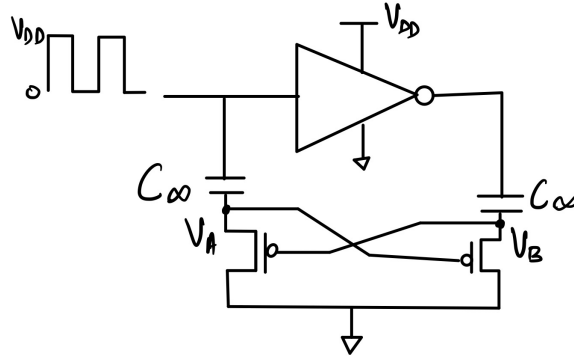# Analog Lab 2022
EE2401

Experiment 4: Charge pump

1. Determine the voltage waveforms of V_A and V_B in steady state in the figure below. Analyze by hand taking into account region of operation for the transistors.

2. NMOS transistors are added to multiplex V_A and V_B resulting in V_{out} as shown in figure below. Use CD4069 ICs to implement this circuit. Use the following values:

   - Clock frequency: $10\,\text{kHz}$
   - Supply voltage: $5\,\text{V}$
   - C_{HI}: $10\,\text{nF}$
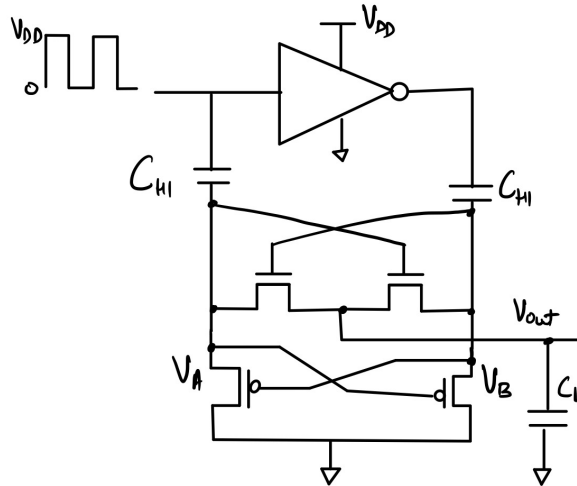
   Simulate and find the output for C_L equal to 0 and $10\,\text{nF}$. Now replace C_L with a current load of $1\,\text{mA}$ to ground. What do you observe?

3. Design and simulate a circuit that gives positive output of close to twice the supply voltage w.r.t. ground.

CAD info:

- Use model of the inverter provided in Experiment 1.

- CD4069 https://www.ti.com/product/CD4069UB

- PSPICE models can be used in LTspice using this procedure: https://www.analog.com/en/technical-articles/ltspice-simple-steps-to-import-third-party-models.html

Submit the following:

- Testbench snapshot, output plots

- Hand calculation

- Any unusual observation along-with comments