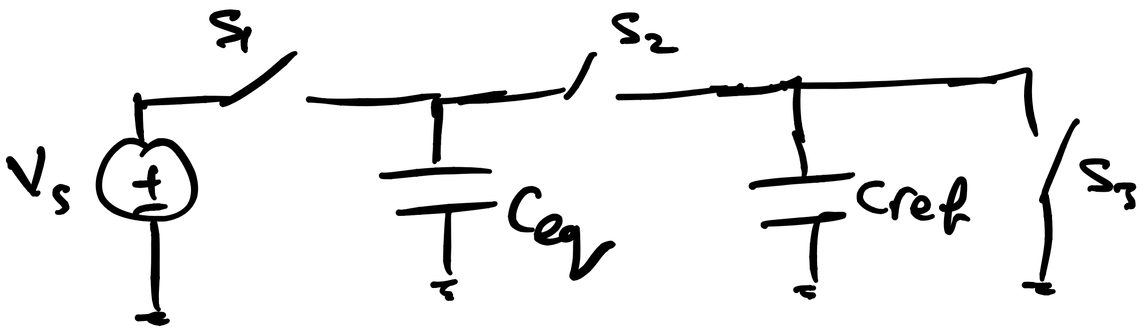
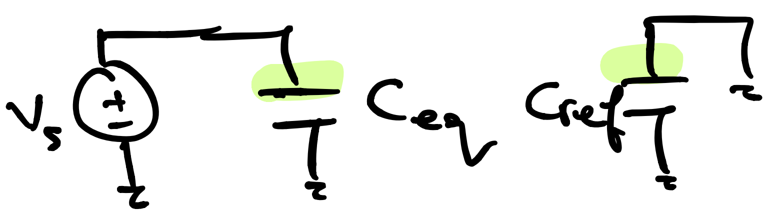
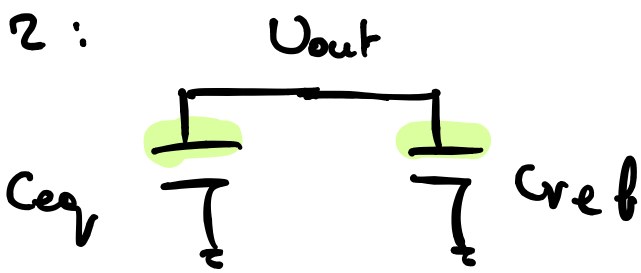
Charge Sharing Walk-Through



Phase 1 :



Phase 2 :



$$Q_{V_{out}}^{\varphi_2} = V_{out} \cdot (C_{eq} + C_{ref})$$

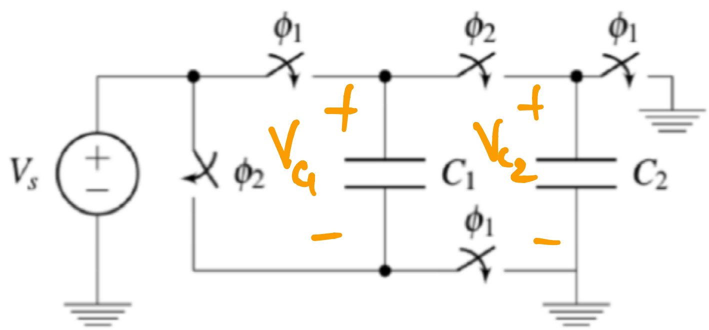
$$Q_{V_{out}}^{\varphi_1} = C_{eq} \cdot V_{ceq}^{\varphi_1} + C_{ref} \cancelto{0}{V_{cref}^{\varphi_1}}$$

$$Q^{\varphi_1}_{v_{out}} = Q^{\varphi_2}_{v_{out}} \Rightarrow$$

$$v_{out} = \frac{C_{eq}}{C_{eq} + C_{ref}} \cdot V_s$$

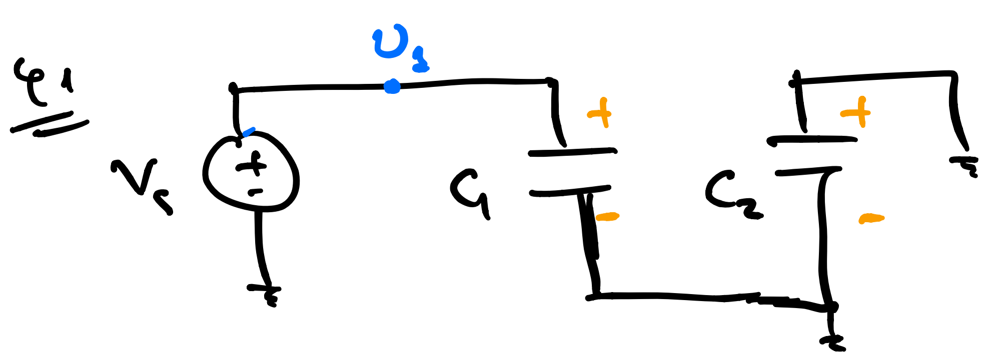
How about more complicated problems?

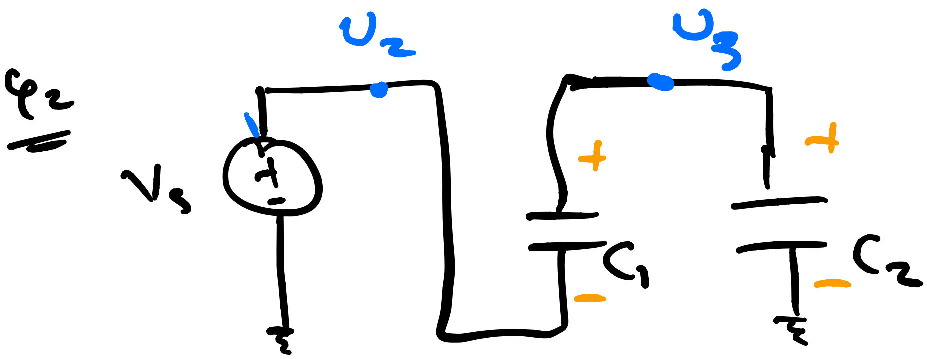
For the switch capacitor circuit below, calculate the value of all node voltages at the end phase 2, as a function of the voltage source V_s and the capacitors C_1, C_2.



Step 1: Label capacitor polarity

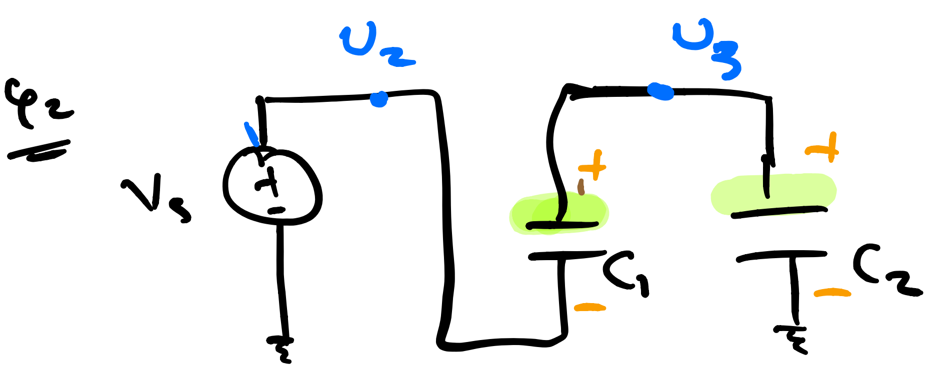
Step 2: Redraw the ckt during the two phases





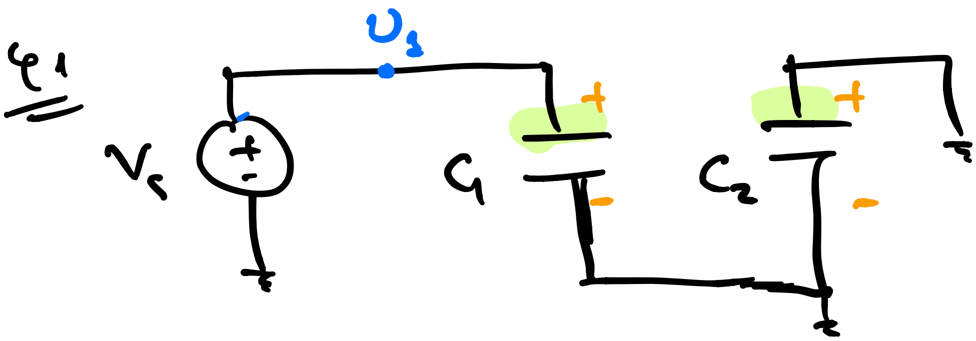
Step 3 : (Important)

Identify all "floating" nodes during phase 2. Those are the nodes where we will apply charge conservation (sharing).



v_3 is our only floating node!

Step 4: Identify all capacitor plates connected to my floating node (phase 2). Calculate the charge on these plates during phase 1.

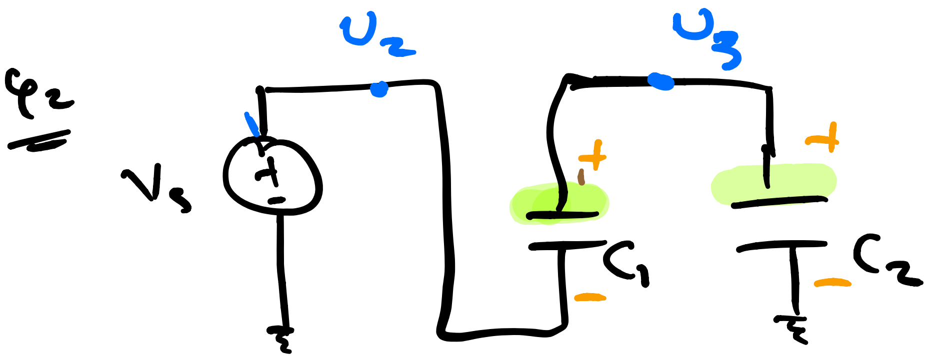


$$Q_{v_3}^{\varphi_1} = +C_1 V_{C_1}^{\varphi_1} + C_2 V_{C_2}^{\varphi_1}$$

$$= C_1(v_1 - 0) + \cancel{C_2(0 - 0)}^{\,0}$$

$$= C_1 \cdot V_s \quad (1)$$

Step 5: Calculate the total charge on the floating node during phase 2



$$Q_{v_3}^{\varphi 2} = +C_1 V_{C_1}^{\varphi 2} + C_2 V_{C_2}^{\varphi 2}$$

$$= C_1(v_3 - v_2) + C_2(v_3 - 0)$$

$$= C_1(v_3 - V_s) + C_2 v_3 \quad (2)$$

Step 6: Equate the charges from phase 1 and phase 2 → charge conservation
(step 4) (step 5)

$$(1),(2): \quad C_1 \cdot V_s = C_1(v_3 - V_s) + C_2 v_3$$

$$\Rightarrow 2C_1 V_s = (C_1 + C_2) v_3$$

$$\Rightarrow \boxed{v_3 = \frac{2C_1}{C_1 + C_2} \cdot V_s}$$