Homework 9

1. Thevenin Circuit

$$R_{new} = \frac{3\cdot(4.5+1.5)}{3+4.5+1.5} = \frac{18}{9} = 2$$

$$V_A = \frac{2}{2+3}\cdot V_S = \boxed{4V}$$

$$V_B = \frac{1.5}{4.5+1.5}\cdot V_A = \frac{1.5}{6}\cdot \cancel{4} = \boxed{1V}$$

$$\therefore V_A - V_B = 4 - 1 = \underline{\underline{3V}}$$

Norton Circuit.

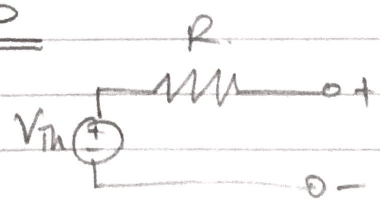
$$R_{new} = \frac{(1.5)(3)}{1.5+3} = \underline{\underline{1\,\Omega}}$$

$$V_C = \frac{1}{3+1}\cdot V_S = 2.5$$

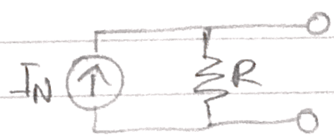
$$\therefore I_{R4} = \frac{2.5}{1.5} = \underline{\underline{\frac{5}{3}}}\text{ A}$$

$$\therefore R_{Th} = \frac{3}{(5/3)} = \underline{\underline{\frac{9}{5}}}\,\Omega$$

Thevenin Circuit :

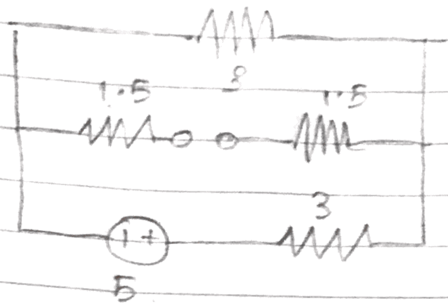


Norton Circuit



2.

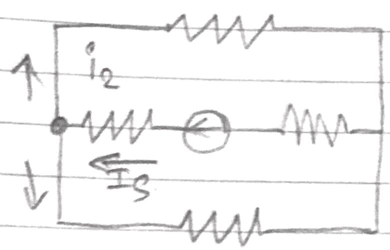
a) Turn off current source:



$V = IR$

$$I = \frac{5}{3+3} = \frac{5}{6}\ A.$$

b)



$\boxed{KCL}$

$\therefore I_s = i_1 + i_2$

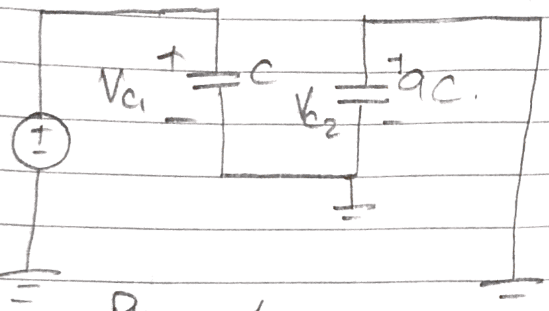
$$2i_2 = +1$$

$$i_2 = \frac{1}{2}\ A$$

By superposition, $-\frac{5}{6} + \frac{1}{2} = \frac{-1}{3}\ A$

3.

a)



Phase 1

$V_{C_1,1} = V_{source} - 0 = \boxed{V_{source}}$

$V_{C_2,1} = 0 - 0 = \boxed{0}$

$Q_{C,1} = V_{C_1,1} C_1 = CV_{source}$

$Q_{C_2,1} = V_{C_2,1} C_2 = 0$

4. $Q = VC$

$$I = \frac{dV}{dt} C$$

$$I = \frac{V_{init} - V_{min}}{t_{store}} C_{bit}$$

$$= \frac{(1.2 - 0.9)}{1 \times 10^{-3}} \cdot 28f$$

$$= \underline{8.4\,pA}$$

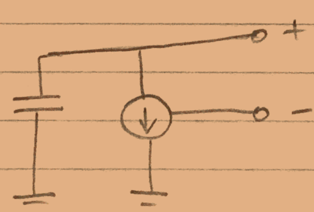
5. $$I_S = C_2 \frac{dV_{out}(t)}{dt}$$

$$V_{out} = \int \frac{I_s}{C_2} dt$$

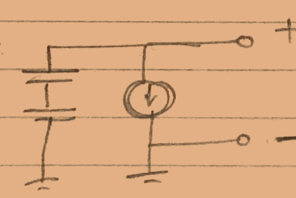
$$= \frac{I_s t}{C_2} + V_{out}(0)$$

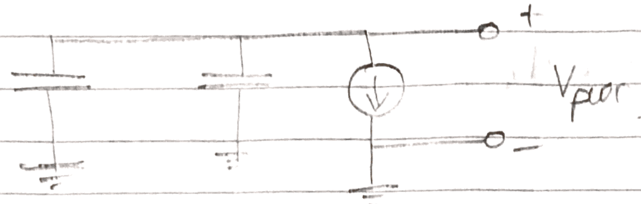
$$= \frac{I_s t}{C_2}$$

6.
a) Config 1 :



b) Config 2 :





b) Case 1:

$$V_{pwr} = \frac{Q}{C_{sc}}$$

$$= \frac{Q_{init} - i_{load}t}{C_{sc}}$$

$$= \frac{V_{init}C_{sc} - i_{load}t}{C_{sc}}$$

$$= V_{init} - \frac{i_{load}t}{C_{sc}}$$

Case 2:

$$V_{pwr} = \frac{Q}{C_{eq}}$$

$$= \frac{Q_{init} - i_{load}t}{C_{eq}}$$

$$= \frac{V_{init}C_{sc} - i_{load}t}{C_{eq}}$$

$$= 2V_{init} - \frac{2i_{load}t}{C_{sc}}$$

Case 3.

$$V_{pwr} = \frac{Q}{C_{eq}}$$

$$= \frac{Q_{init} - i_{load}t}{C_{eq}}$$

$$= \frac{2V_{init}C_{sc} - i_{load}t}{C_{eq}}$$

$$= V_{init} - \frac{i_{load}t}{2C_{sc}}$$

7.

a) $$C_{full} = \frac{\varepsilon_{H_2O}\, h \cdot \omega}{\omega} = 81 \cdot \varepsilon \cdot h_{tot}$$

$$C_{empty} = \frac{\varepsilon_{air}\, h \cdot \omega}{\omega} = \varepsilon h_{tot}.$$

b) $$C_{water} = \frac{\varepsilon_{H_2O} h_{H_2O} \omega}{\omega} = 81 \varepsilon h_{H_2O}.$$

$$C_{air} = \frac{\varepsilon_{air} (h_{tot} - h_{H_2O}) \omega}{\omega} = \varepsilon (h_{tot} - h_{H_2O}).$$

$$C_{tank} = C_{water} + C_{air} = \varepsilon (h_{tot} + 80 h_{H_2O}).$$

c) $$I_c = C_{tank} \frac{dV_c}{dt}.$$

$$I_c = I_s$$

$$\frac{dV_c}{dt} = \frac{I_s}{C_{tank}}.$$

$$V_c = \frac{I_s}{C_{tank}} t.$$

d) $$C_{tank} = \frac{I_s}{V_c(t)} \cdot t.$$

$$h_{H_2O} = \frac{C_{tank} - h_{tot} \cdot \varepsilon}{80 \varepsilon}.$$

e) $$V_c = \frac{I_s}{C_{tank}} \cdot t.$$

$$C_{tank} = \frac{I_s \cdot T_1}{V_{ref}}$$

$$h_{H_2O} = \frac{C_{tank} - h_{tot} \varepsilon}{80 \varepsilon}$$