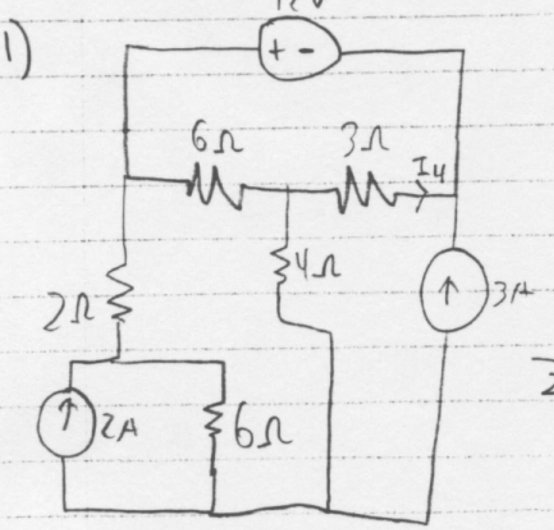
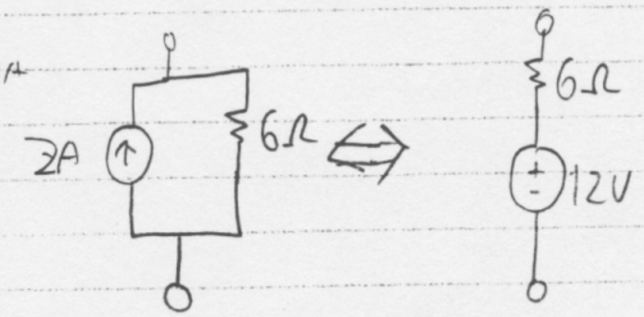
EECS 40

Homework # 3: Solutions

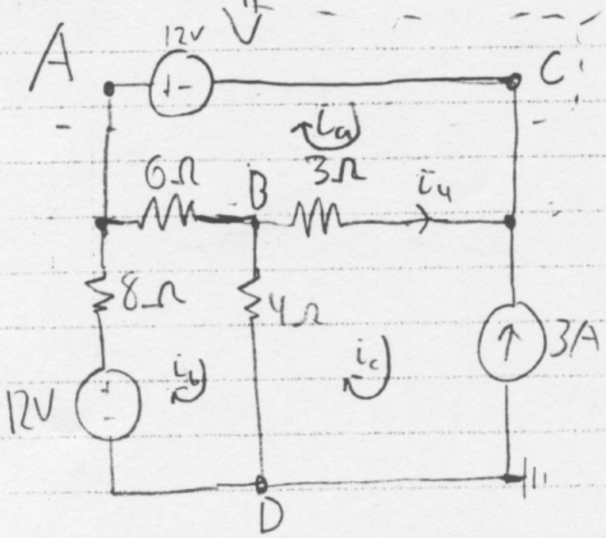
1)



USING SOURCE TRANSFORMATION



SUPERNODE



a) NODE-ANALYSIS

$$(1)\ \left(\frac{V_A-12}{8}\right)+\left(\frac{V_A-V_B}{6}\right)+\left(\frac{V_C-V_B}{3}\right)-3=0 \qquad (A)$$

$$(2)\ \left(\frac{V_B-V_A}{6}\right)+\left(\frac{V_B-V_C}{3}\right)+\left(\frac{V_B}{4}\right)=0 \qquad (B)$$

$$(3)\ V_A-V_C=12$$

$\therefore\ V_A=20 \quad V_B=V_C=8V$

$\therefore\ i_4=\frac{V_B-V_C}{3}=$ **0A**

b) MESH ANALYSIS

Loop ACBA: $12V+3(i_a-i_c)+6(i_a-i_b)=0$

ABDA: $-12+8i_b+6(i_b-i_a)+4(i_b-i_c)=0$

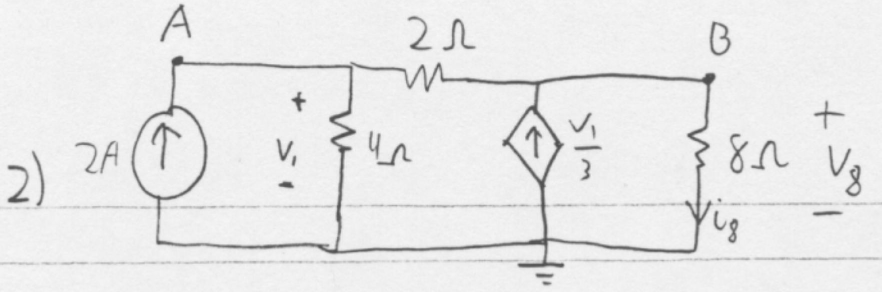
$i_c=-3A$

$i_a=-3A$

$i_b=-1A \Rightarrow$ **$i_4=i_c-i_a=0A$**

$i_c=-3A$

2)



NODE ANALYSIS at A & B

Node A: $2 - \frac{V_1}{4} - \frac{V_1 - V_8}{2} = 0$

Node B: $\frac{V_1}{3} - \frac{V_8 - V_1}{2} - \frac{V_8}{8} = 0$

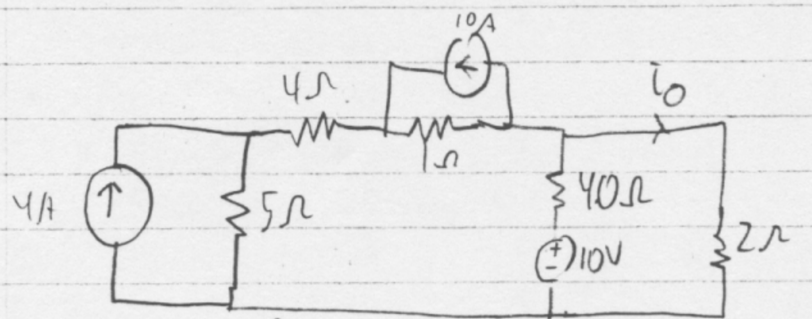
$\Rightarrow$ $V_8 = 32\,V$

$V_1 = 24\,V$

$P = IV = \frac{V^2}{R} = \frac{32^2}{8\Omega} = 128$ Watts

The 8Ω resistor is <u>absorbing</u> 128 Watts

3)



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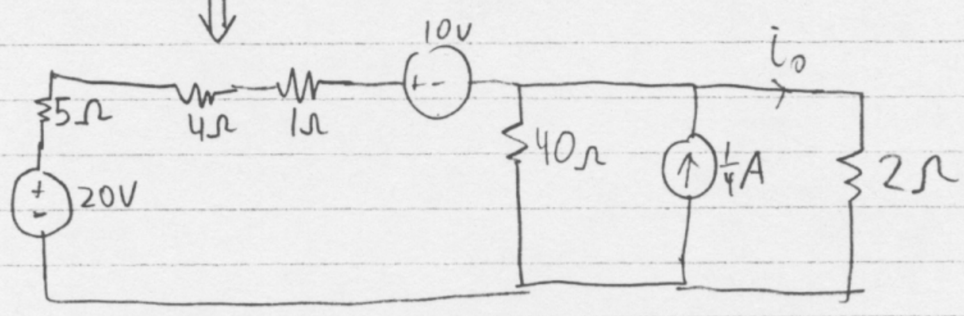

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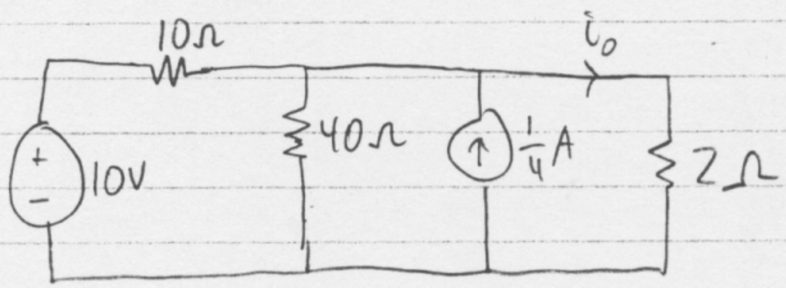
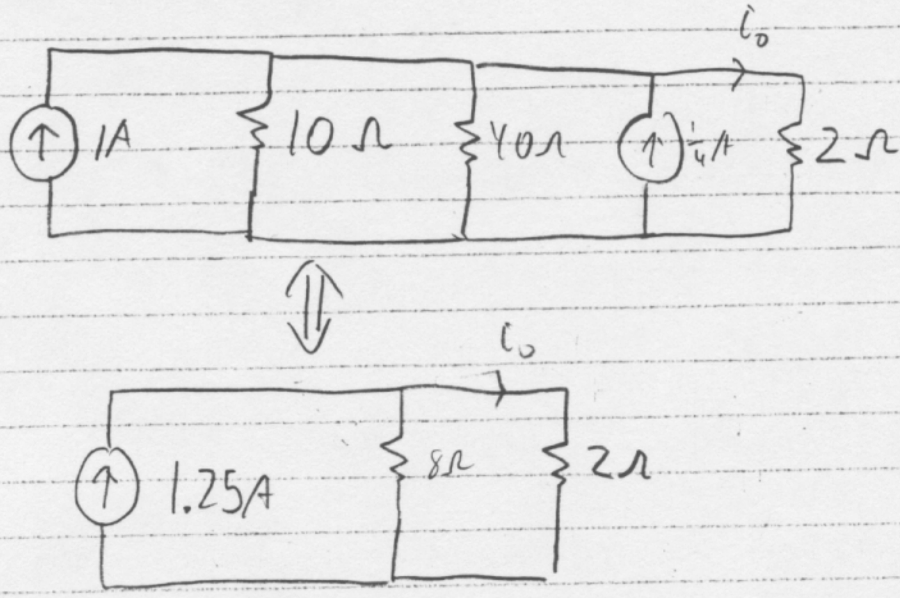


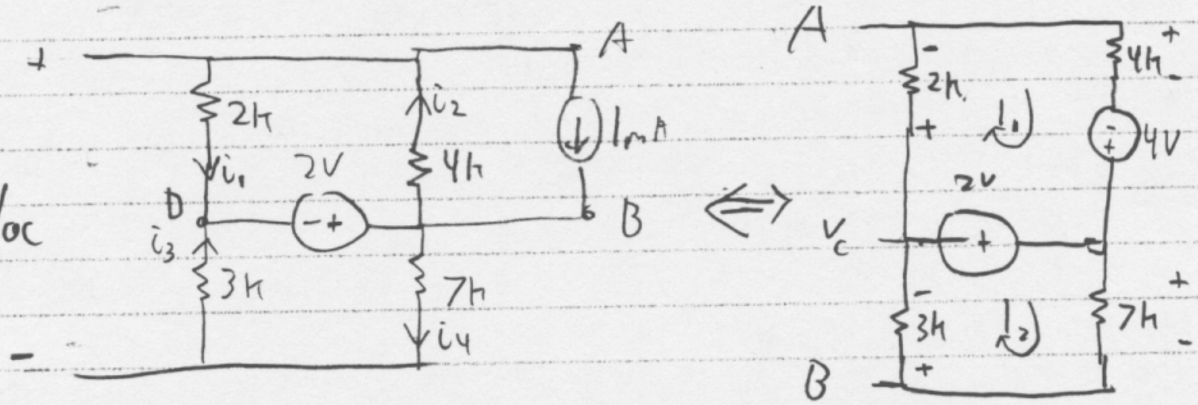
EQUIVALENTLY,



CURRENT DIVIDER

$$i_o = (5/4)\left(\frac{8}{8+2}\right) = 5\left(\frac{2}{10}\right) = \boxed{1A}$$

4)



Mesh Analysis

$0 = -4V + 2V + 2k\,i_1 + 4k\,i_1 \Rightarrow \quad i_1 = \frac{2}{6}\ mA$

$0 = -2 + 7k\,i_2 + 3k\,i_2 \Rightarrow \quad i_2 = \frac{2}{10}\ mA$

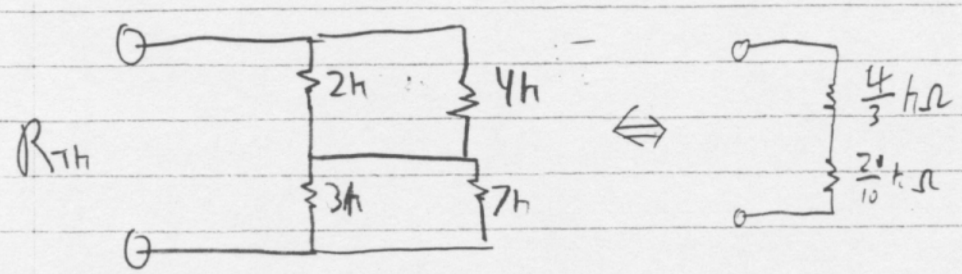
$V_b - V_c = (3k)(i_2) = .6\ V$

$V_c - V_a = (2k)(i_1) = .6\bar{6}\ V$

$V_{AB} = V_{OC} = V_{TH}$

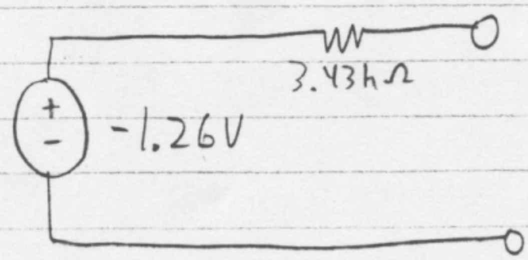
$-(V_c - V_a) - (V_b - V_c) = V_a - V_b = -1.266\ V$

R_{TH} - turn off all sources



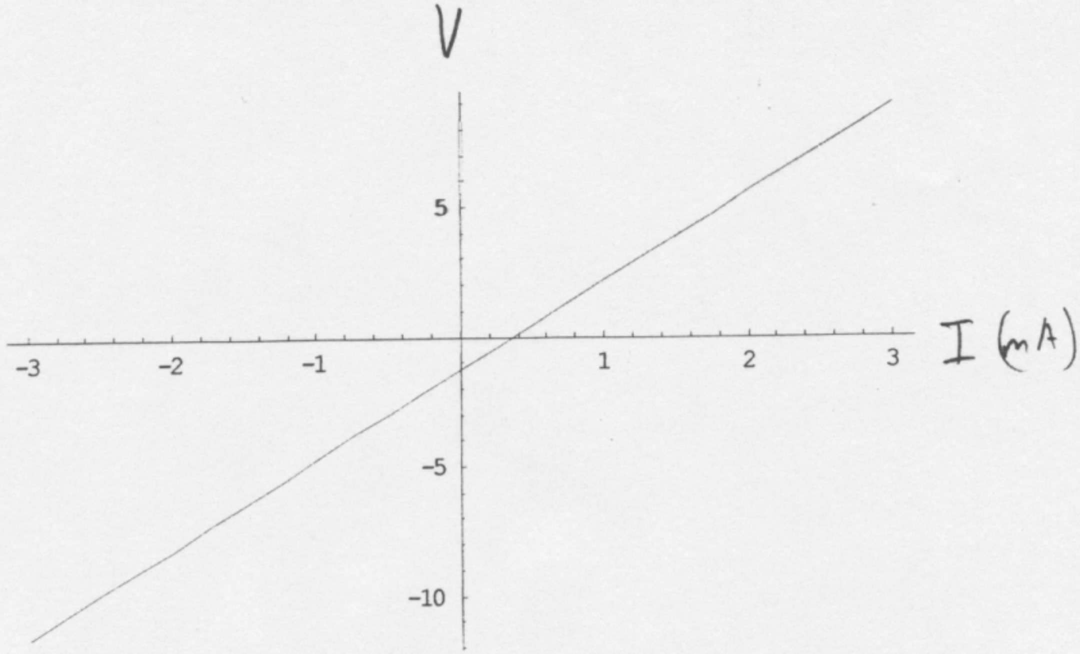
$R_{TH} = \left(\frac{103}{30}\right) k\Omega = 3.43\, k\Omega$

THEVENIN EQUIVALENT

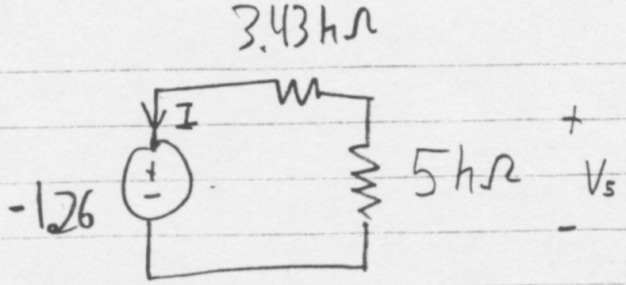


b) I-V $\quad v = V_{TH} + iR = -1.26 + 3430\, i$

4) part b)



4) c)



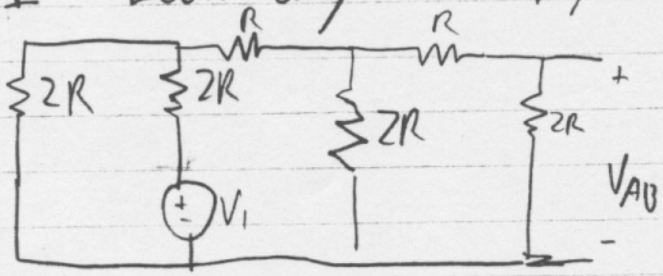
$$I = \frac{-V}{R} = \frac{+1.26}{(3.43+5)k} = +.1502\,mA$$

PASSIVE SIGN CONVENTION

$$P = IV = (-1.26)(.1502)\,mW = -.189\,mW$$

(Power is being delivered)

5) 1st - Look only at V_1 ; $V_2 = V_3 = 0$



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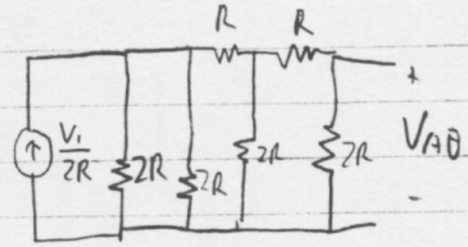

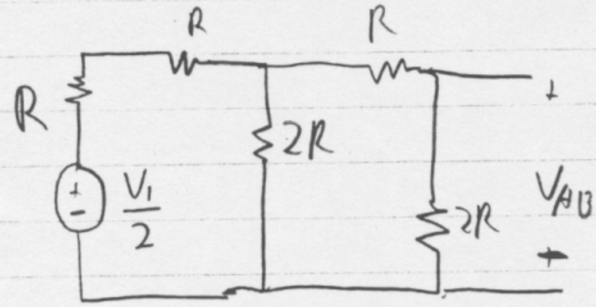

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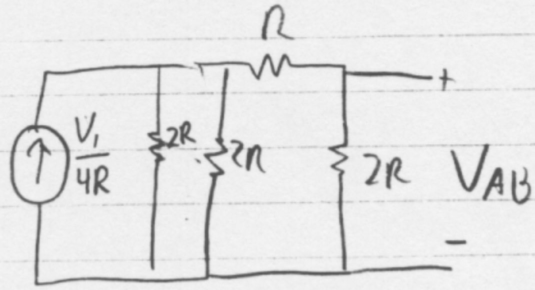

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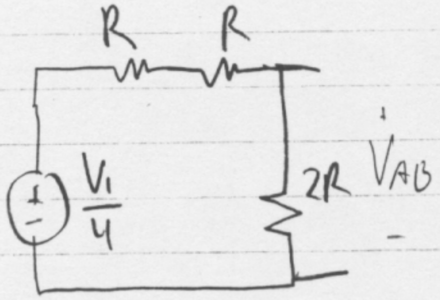
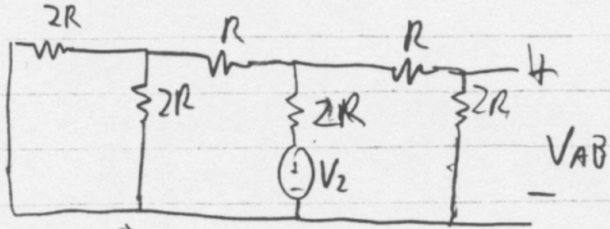
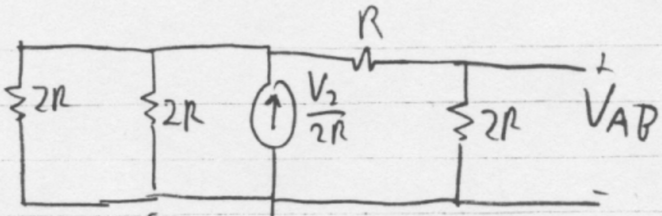


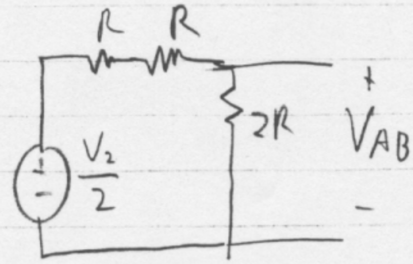
VOLTAGE DIVIDER

$$V_{AB}^{(1)} = \left(\frac{V_1}{4}\right)\left(\frac{2R}{2R + 2 \cdot R}\right) = \frac{V_1}{8}$$

2^{nd} $V_1 = V_3 = 0$

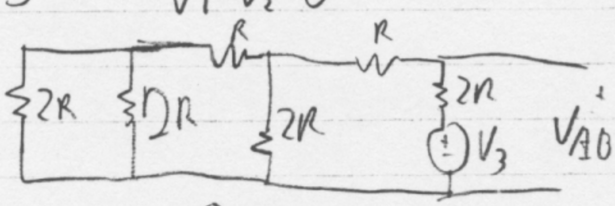




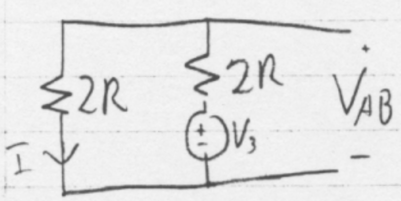


$$V_{AB}^{(2)} = \left(\frac{V_2}{2}\right)\left(\frac{2R}{2R+2R}\right) = \frac{V_2}{4}$$

3^{rd} $V_1 = V_2 = 0$



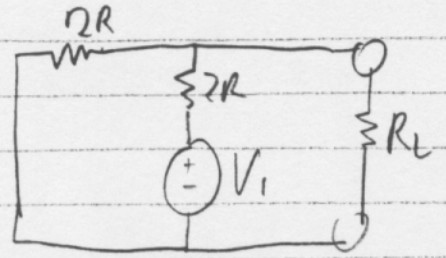
$$I = \frac{V_3}{4R}$$



$$V_{AB}^{(3)} = (2R)(I) = \frac{V_3}{2}$$

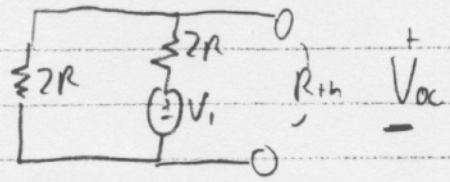
$$\therefore\ V_{AB} = V_{AB}^{(1)} + V_{AB}^{(2)} + V_{AB}^{(3)} = \boxed{\frac{V_1}{8} + \frac{V_2}{4} + \frac{V_3}{2}}$$

b) 1^{st} look at the far left part

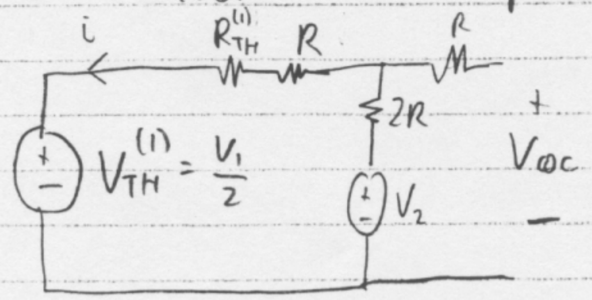


$R_{TH} = R$ (set $V_1 = 0$)

$$V_{TH} = V_{OC} = \frac{V_1}{2}$$



2^{nd} look at next part



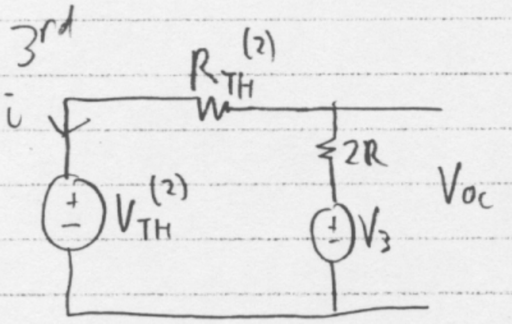
set $V_2 = V_{TH}^{(1)} = 0$

$$R_{TH}^{(2)} = (2R \| 2R) + R = 2R$$

$$i = \frac{V_2 - \frac{V_1}{2}}{4R}$$

$$V_{oc} = V_{TH}^{(2)} = \left(\frac{V_1}{2}\right) + i \cdot 2R$$
$$= \frac{V_1}{4} + \frac{V_2}{2}$$

3^{rd}



$$i = \frac{V_3 - V_{TH}^{(2)}}{4R}$$

$$V_{AB} = V_{OC} = V_{TH}^{(2)} + R_{TH}^{(2)} i = \left(V_{TH}^{(2)}\right) + (2R)\left(\frac{V_3 - V_{TH}^{(2)}}{4R}\right) = \frac{V_{TH}^{(2)}}{2} + \frac{V_3}{2}$$

$$= \frac{V_1}{8} + \frac{V_2}{4} + \frac{V_3}{2}$$