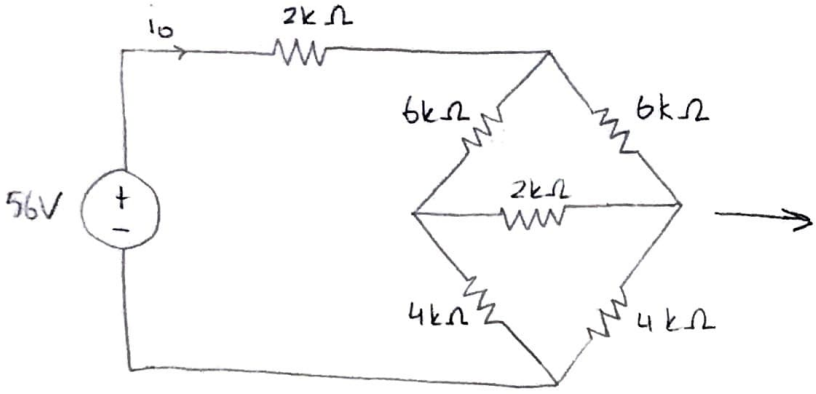
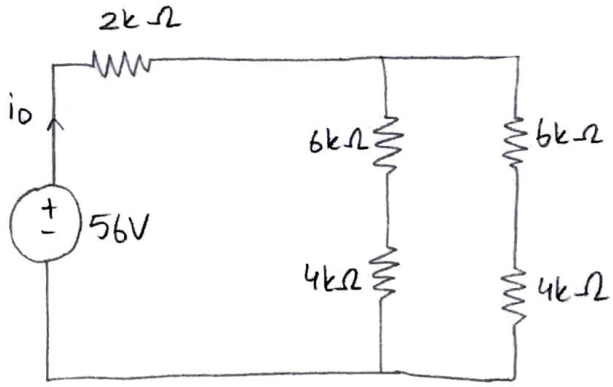
EHB 211E HW2

Ömer Malik Kalemkaş
150180112

Q1. Find i_o.



$\frac{6k\Omega}{4k\Omega} = \frac{6k\Omega}{4k\Omega}$, so there is no current through 2 kΩ resistance.

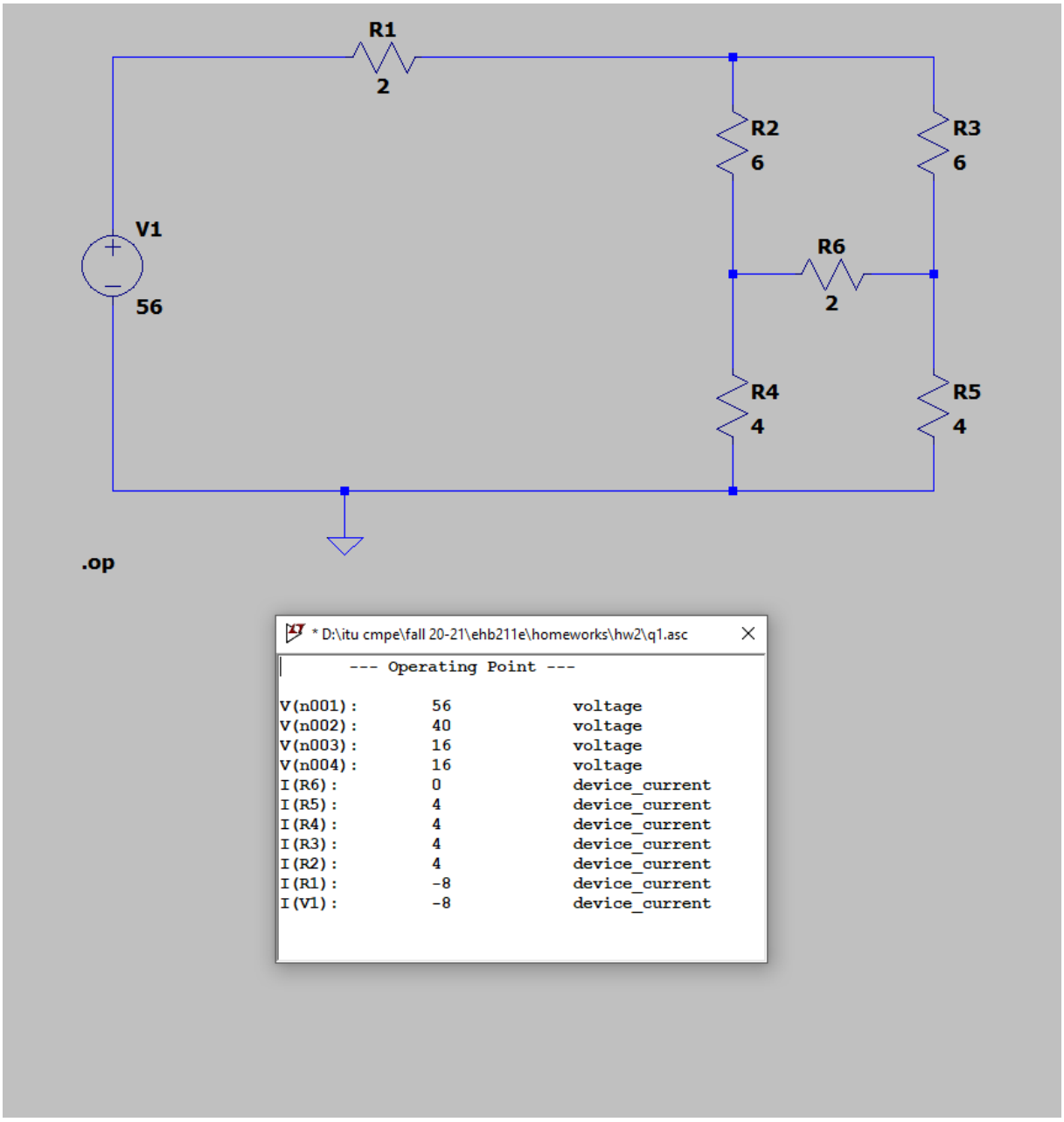


$R_{equivalent} = (2+5)k\Omega$

$56V = i_o \cdot 7000\Omega$

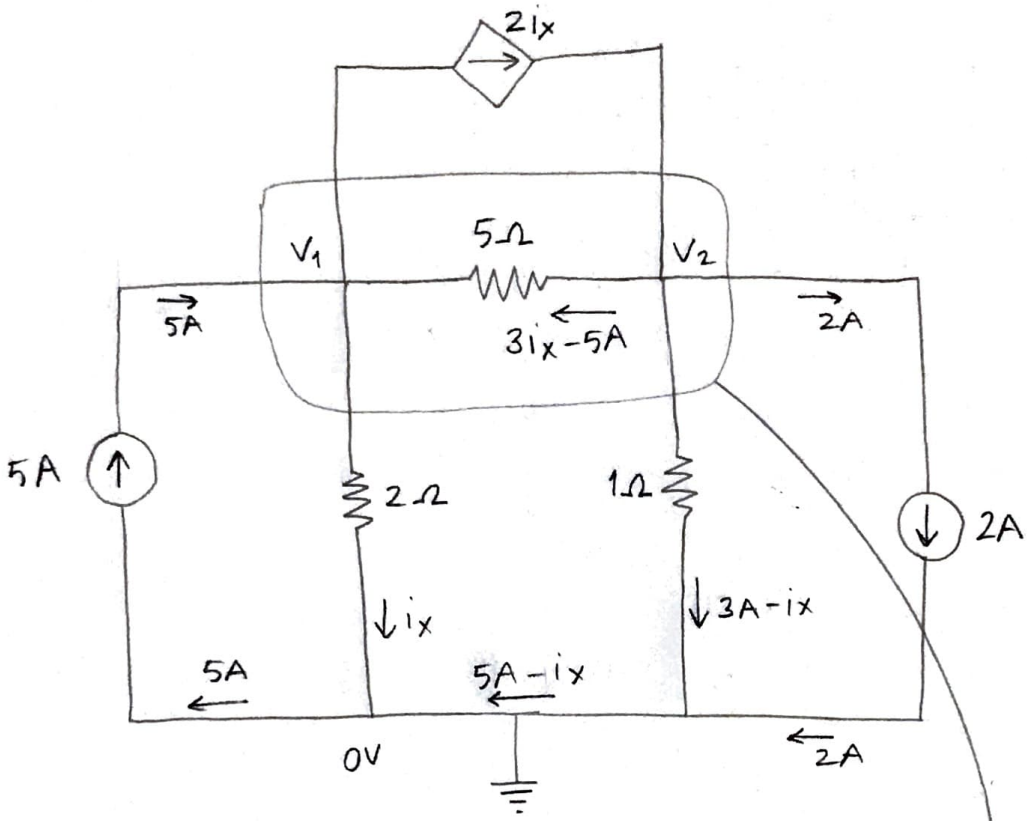
$i_o = 8\ mA$

Q1 simulation:



Ömer Malik Kalemboşı
150180112

Q_2. Find V_1 and V_2



$V_1 - 0 = 2\Omega \cdot i_x$

$V_1 = 2i_x$

$V_2 - 0 = 1\Omega \cdot (3A - i_x)$

$V_2 = 3A - i_x$

$V_2 - V_1 = (3i_x - 5A) \cdot 5\Omega$

$V_2 = 3 - i_x$

$V_1 = 2i_x$

$V_2 - V_1 = 3 - 3i_x$

$3 - 3i_x = (3i_x - 5)\,5$

$3 - 3i_x = 15i_x - 25$

$28 = 18i_x$

$i_x = 1{,}55555556$ A

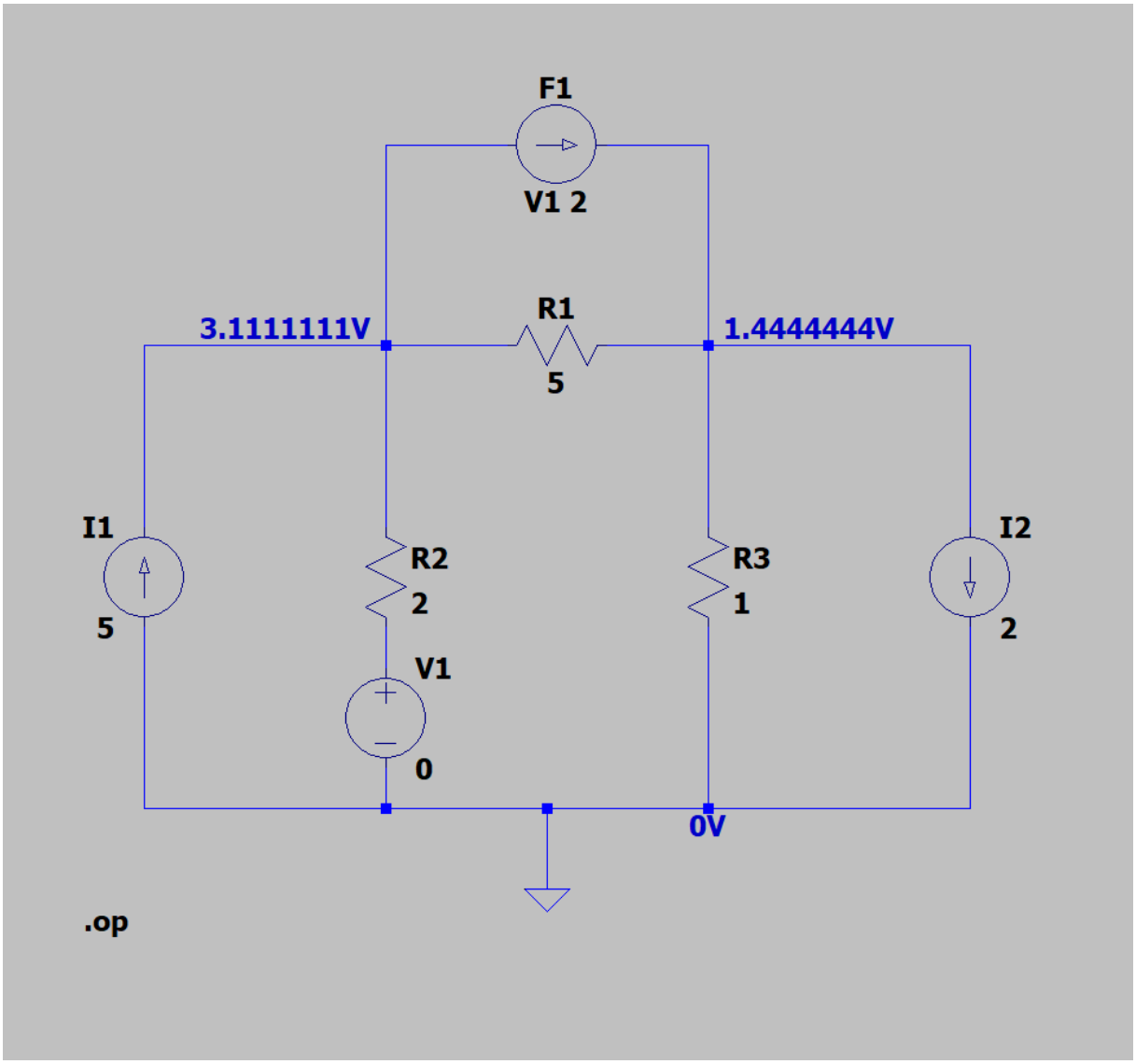
$V_1 = 2 \cdot 1{,}55555556$ V

$\boxed{V_1 = 3{,}11111111 \text{ V}}$

$V_2 = 3 - 1{,}55555556$

$\boxed{V_2 = 1{,}44444444 \text{ V}}$

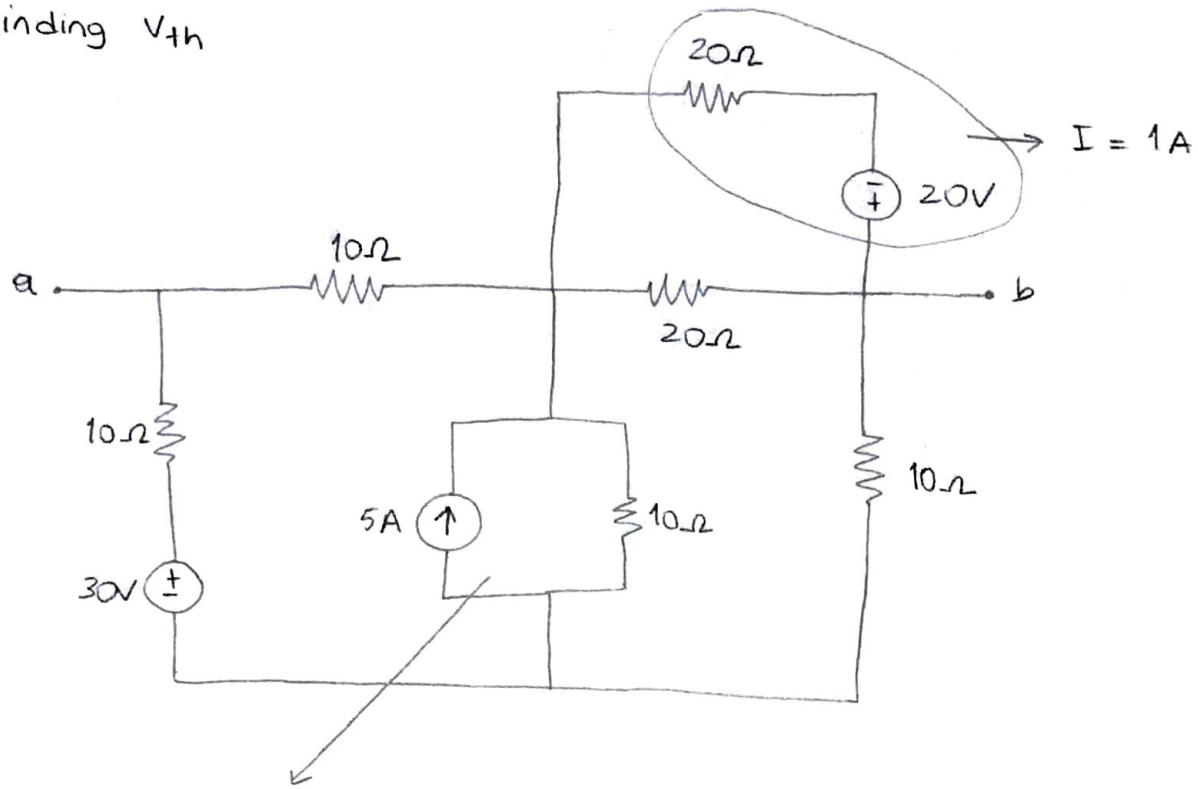
Q2 simulation:



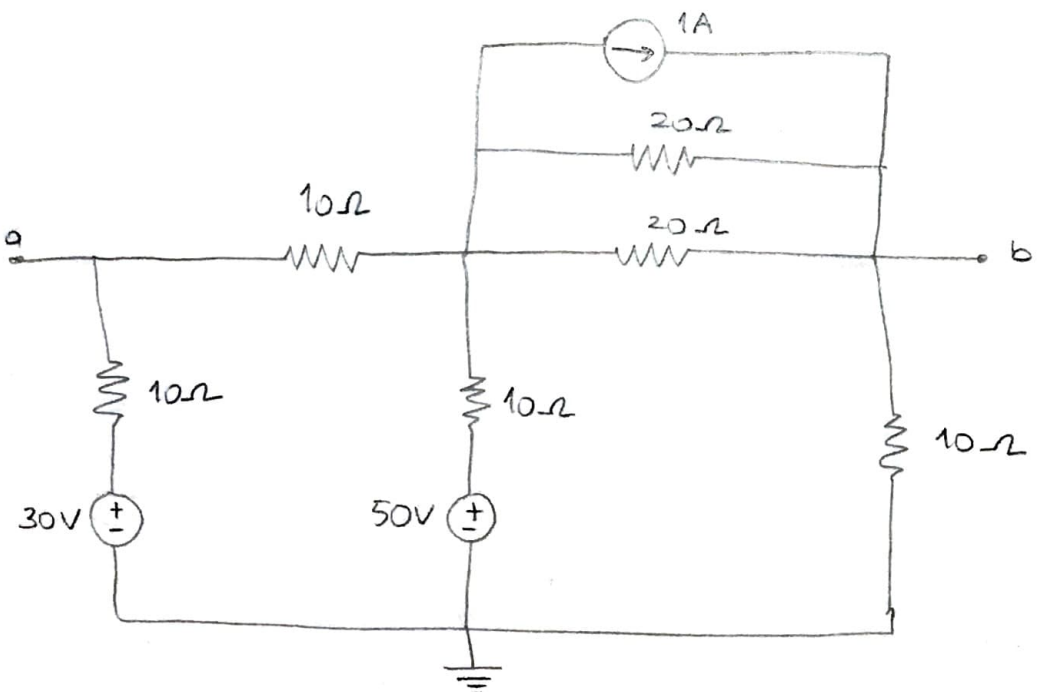
Ömer Malik Kalembaşı
150180112

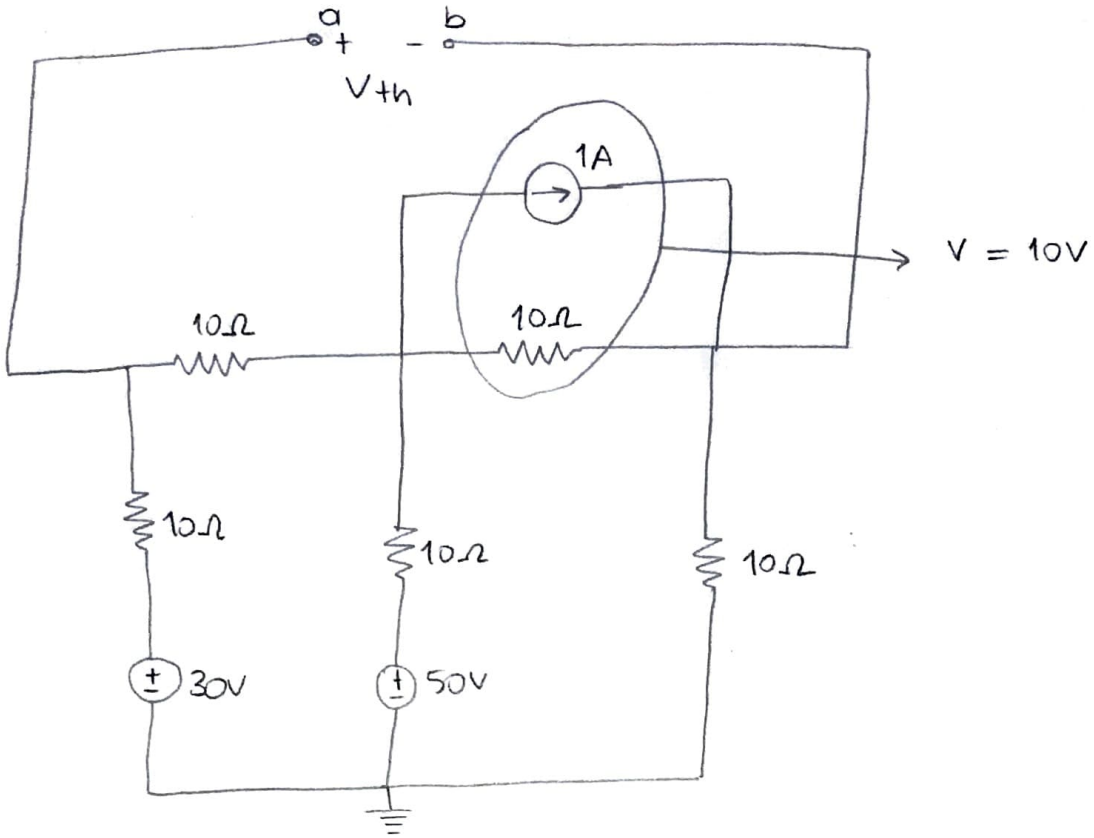
Q_3.

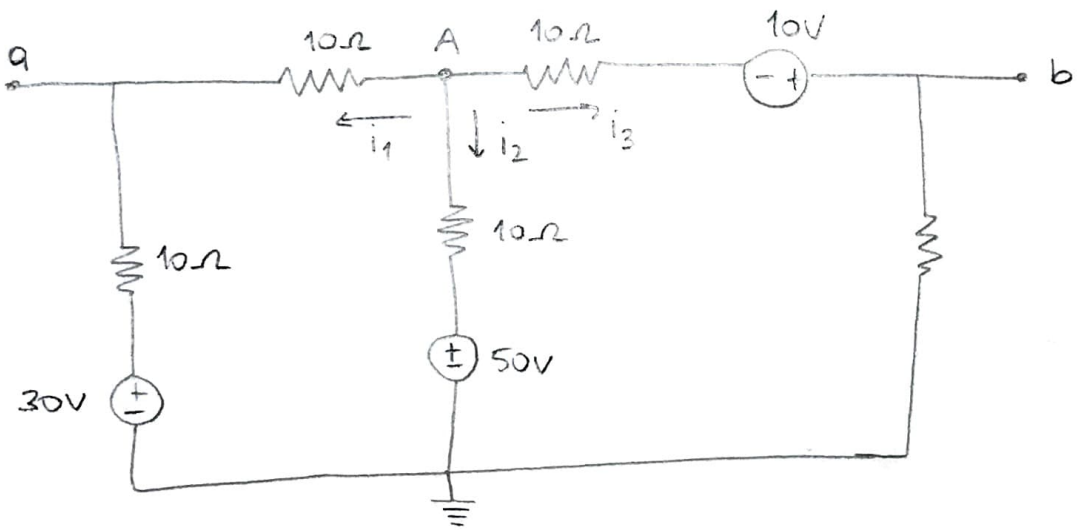
- Finding V_{th}



Voltage = 5A · 10Ω = 50V







$V_{th} = V_a - V_b$

$i_1 + i_2 + i_3 = 0$

KCL for node A :

$$V_A \left(\frac{1}{20} + \frac{1}{10} + \frac{1}{20} \right) = \frac{30}{20} + \frac{50}{10} - \frac{10}{20}$$

$$V_A \cdot 4 = 120 \Rightarrow V_A = 30V$$

$$i_1 = \frac{VA - 30}{20} = 0\ A$$

$$V_a - 10 i_1 - 30 = 0$$

$$V_a = 30 + 10 i_1$$

$$V_a = 30 + 0 \Rightarrow \boxed{V_a = 30\ V}$$

$$i_3 = \frac{V_A + 10}{20} = \frac{30 + 10}{20} = 2\ A$$

$$V_b - 10 i_3 = 0$$

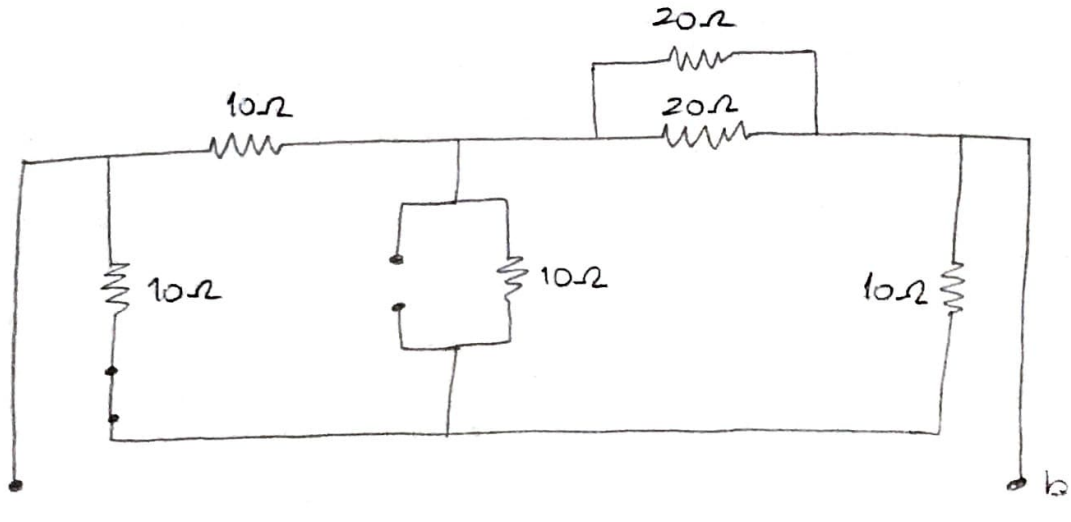
$$V_b - 20 = 0 \qquad \boxed{V_b = 20\ V}$$

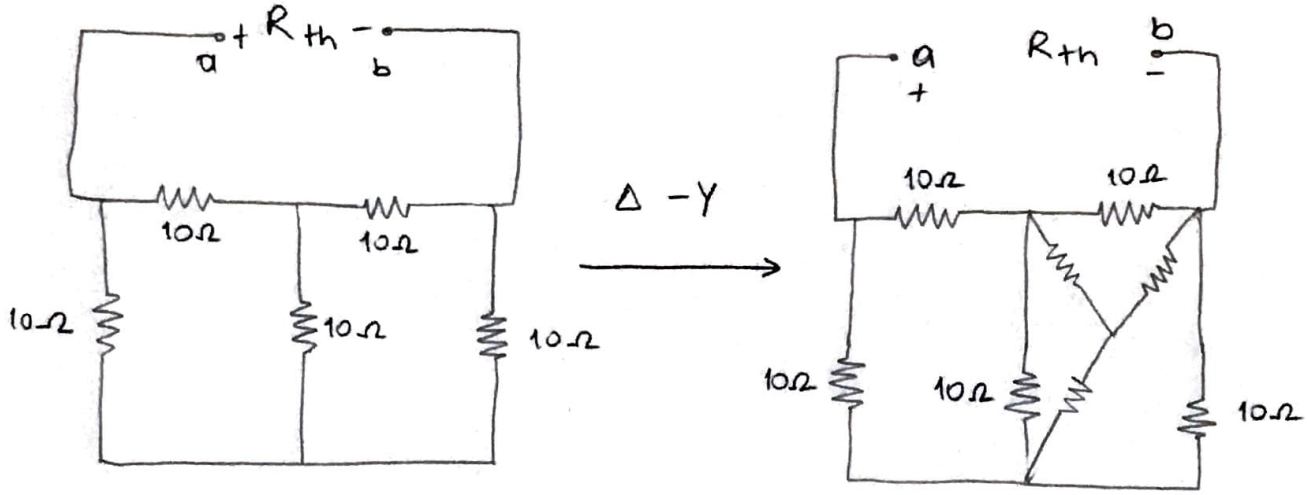
$$V_{th} = V_a - V_b = 10 \qquad \boxed{V_{th} = 10V}$$

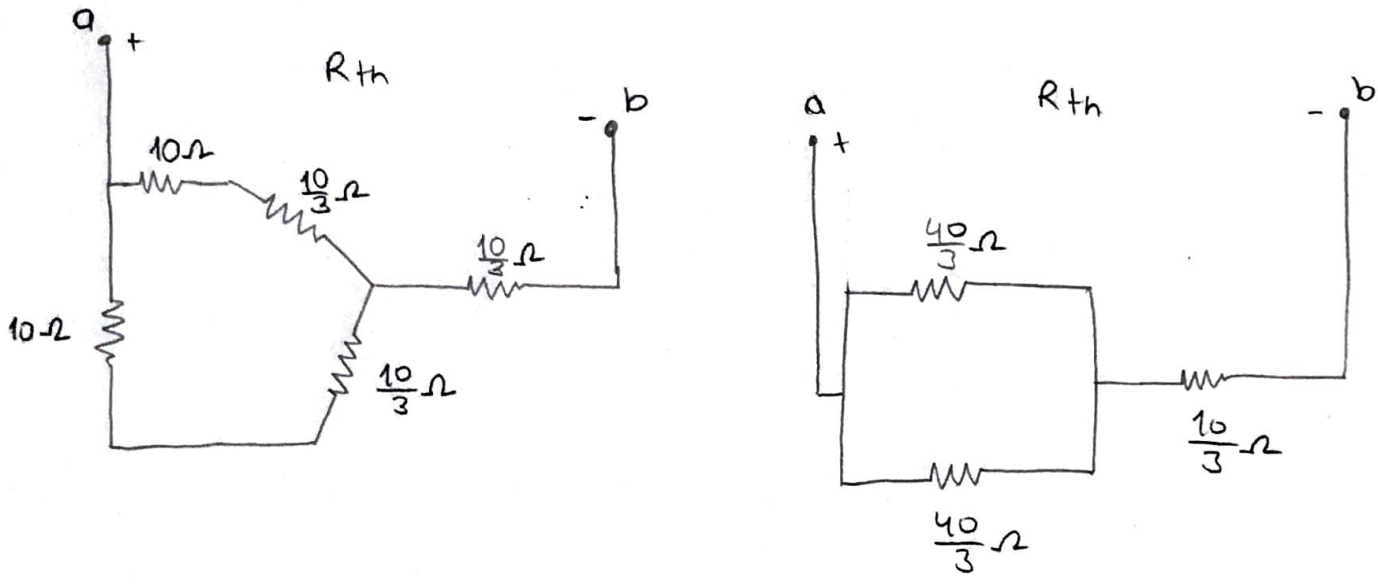
- Finding R_{th}

Voltage source → short circuit

current source → open circuit



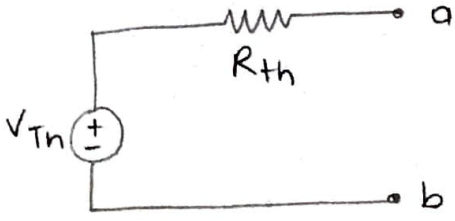




$$R_{equivalent} = \frac{20}{3} + \frac{10}{3} = 10\,\Omega$$

$$\boxed{R_{th} = 10\,\Omega}$$

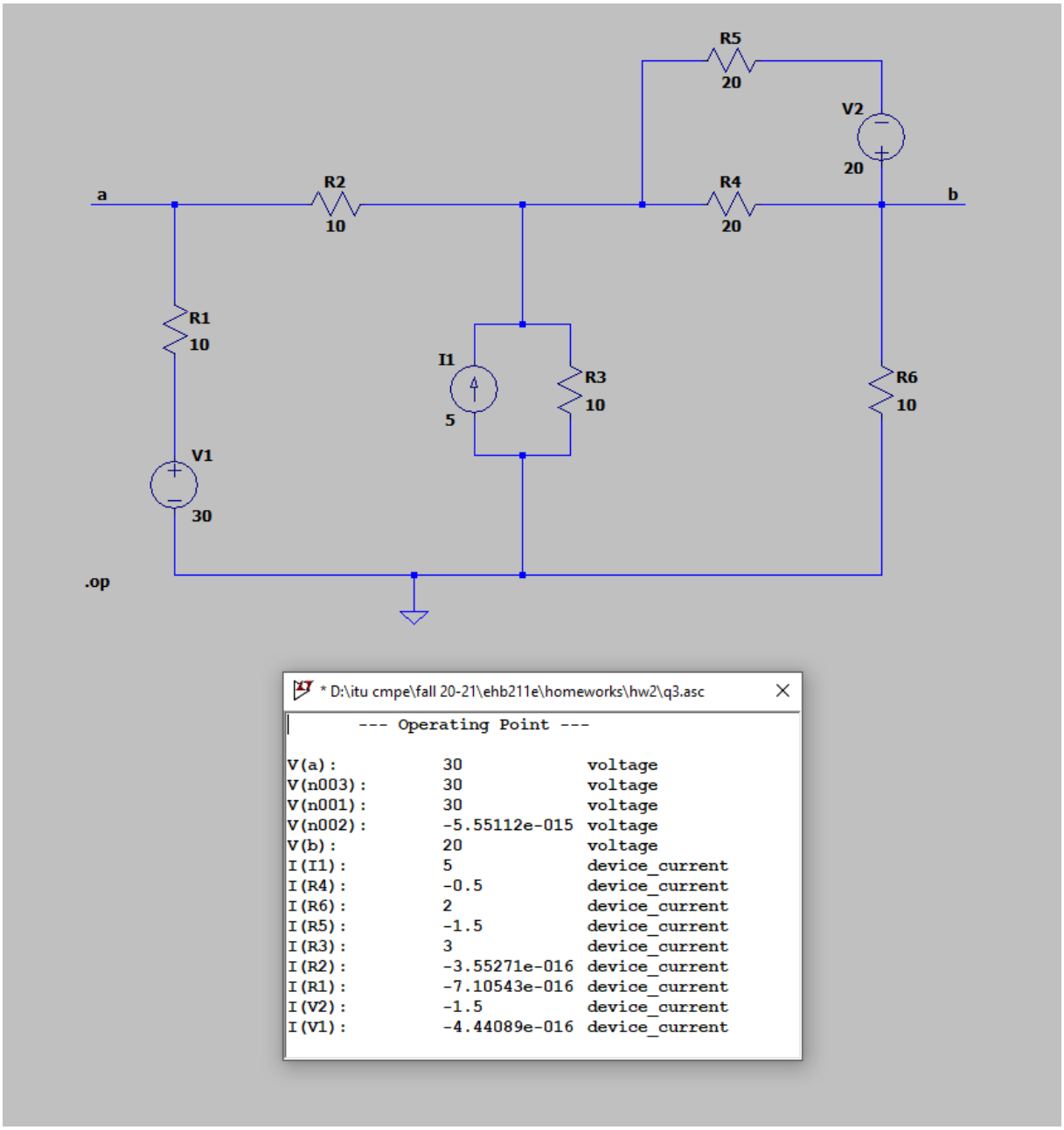
- Thevenin equivalent between terminals a and b:



$V_{th} = 10V$

$R_{th} = 10\,\Omega$

Q3 simulation:

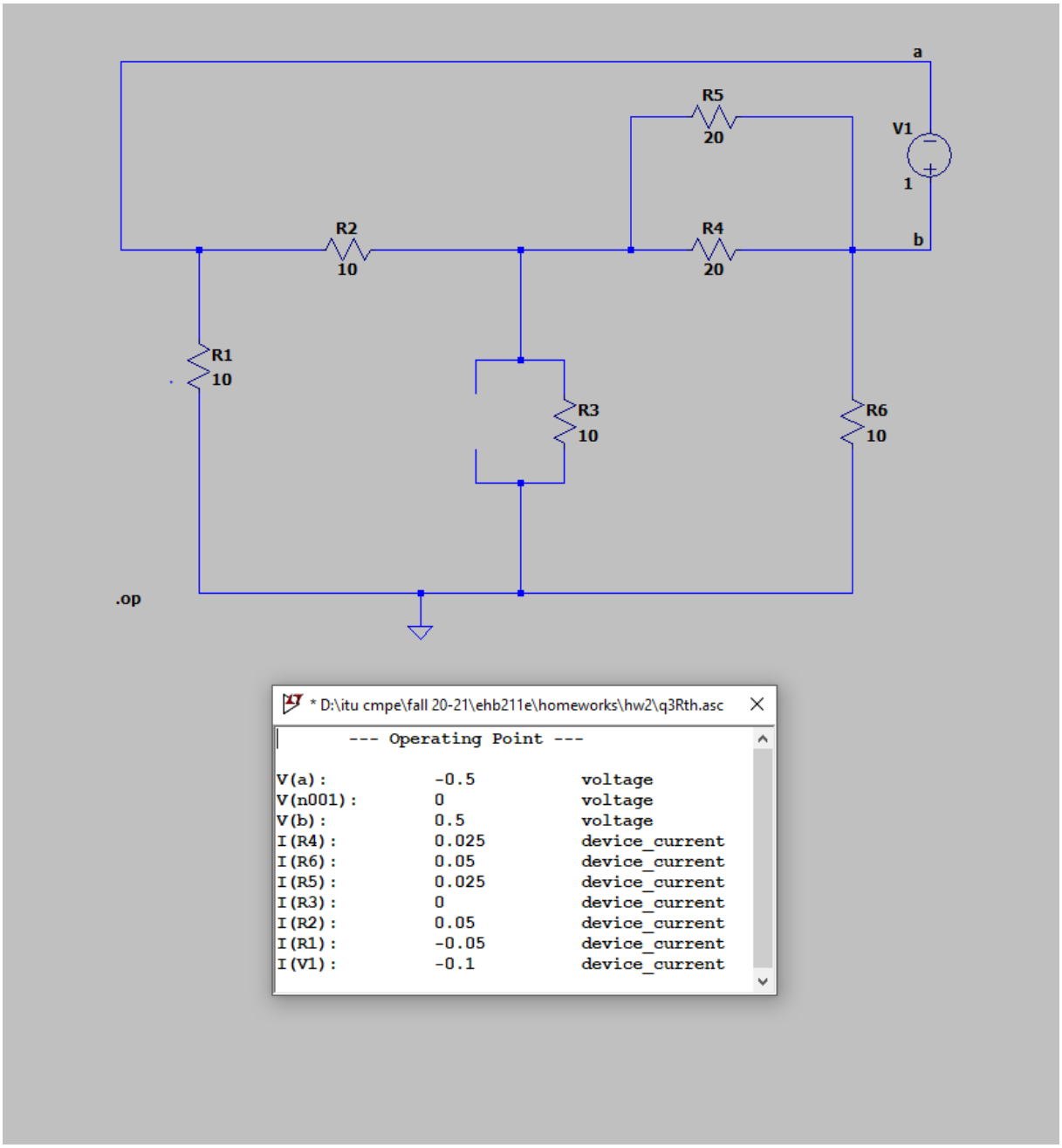


* D:\itu cmpe\fall 20-21\ehb211e\homeworks\hw2\q3.asc

--- Operating Point ---

V(a):	30	voltage
V(n003):	30	voltage
V(n001):	30	voltage
V(n002):	-5.55112e-015	voltage
V(b):	20	voltage
I(I1):	5	device_current
I(R4):	-0.5	device_current
I(R6):	2	device_current
I(R5):	-1.5	device_current
I(R3):	3	device_current
I(R2):	-3.55271e-016	device_current
I(R1):	-7.10543e-016	device_current
I(V2):	-1.5	device_current
I(V1):	-4.44089e-016	device_current

Q3 simulation: Rth



current flows through V1 = 0.1A

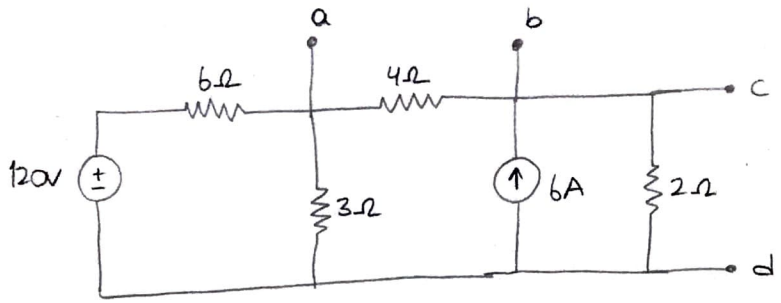
V1 = 1V

1V = 0.1A * Rth

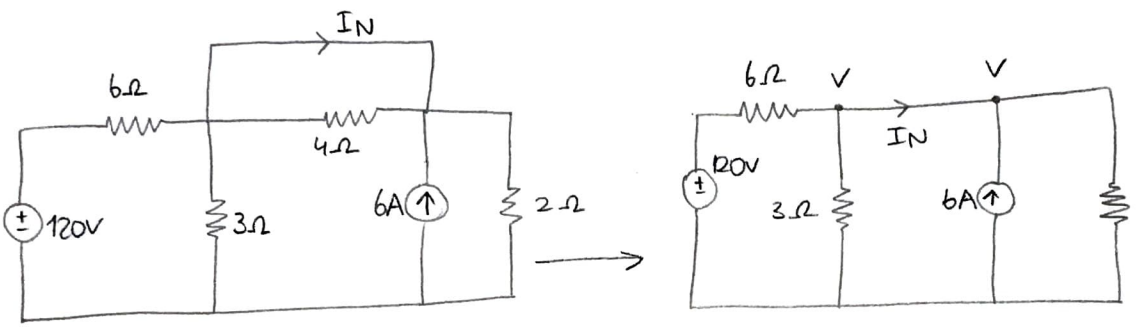
Rth = 10 ohm

Ömer Malik Kalembaşı
150180112

Q.4.



from terminal a - b :



Using nodal analysis:

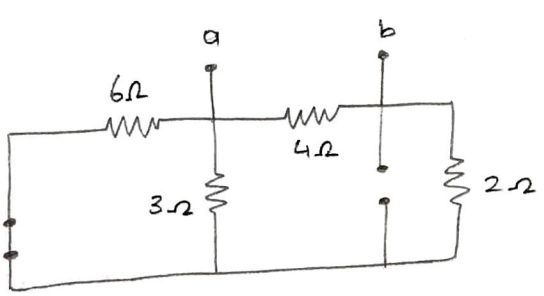
$$\frac{V-120}{6} + \frac{V}{3} - 6 + \frac{V}{2} = 0$$

$$\frac{6V-120}{6} = 6 \Rightarrow V = 26V$$

$$I_N = \frac{120-26}{6} - \frac{26}{3}$$

$$= \frac{94-52}{6} = 7$$

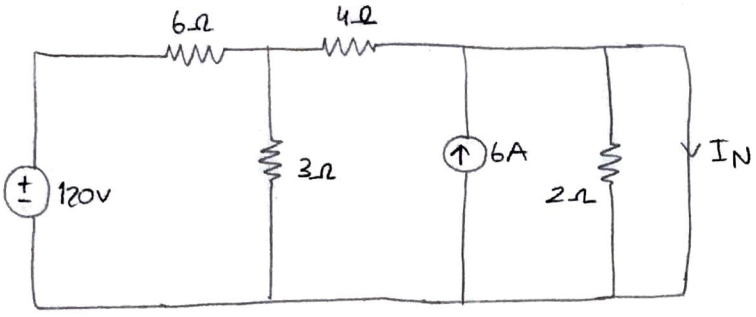
$$\boxed{I_N = 7A}$$

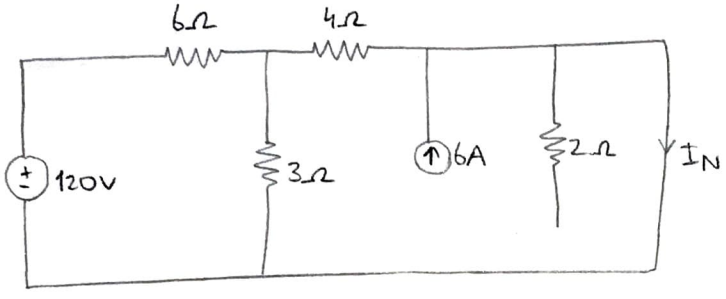


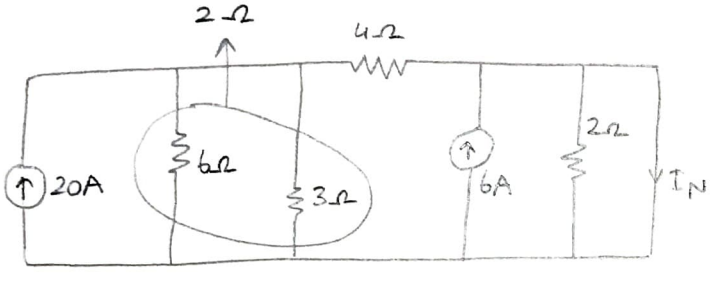
$$R_N = \frac{\left(\frac{6\cdot 3}{6+3} + 2\right)\cdot 4}{\left(\frac{6\cdot 3}{6+3} + 2\right) + 4} = \frac{(2+2)\cdot 4}{(2+2)+4} = 2\Omega$$

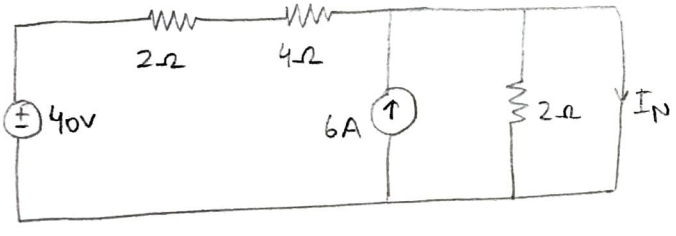
$$\boxed{R_N = 2\Omega}$$

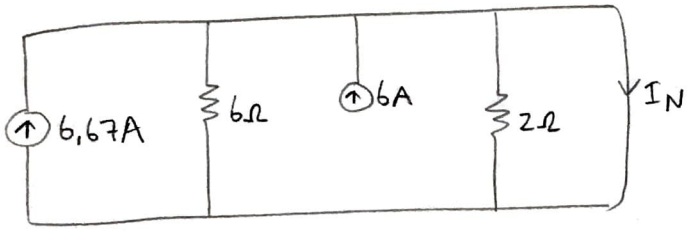
from terminal c-d:

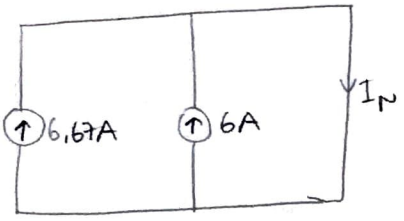






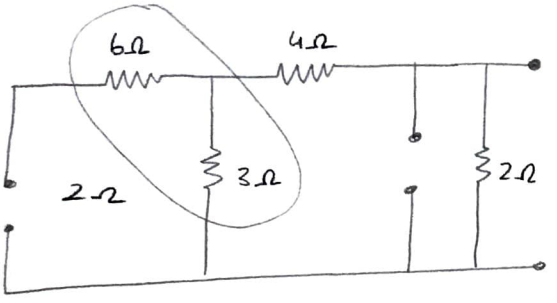






$$I_N = 6,67A + 6A$$

$$\boxed{I_N = 12,67A}$$

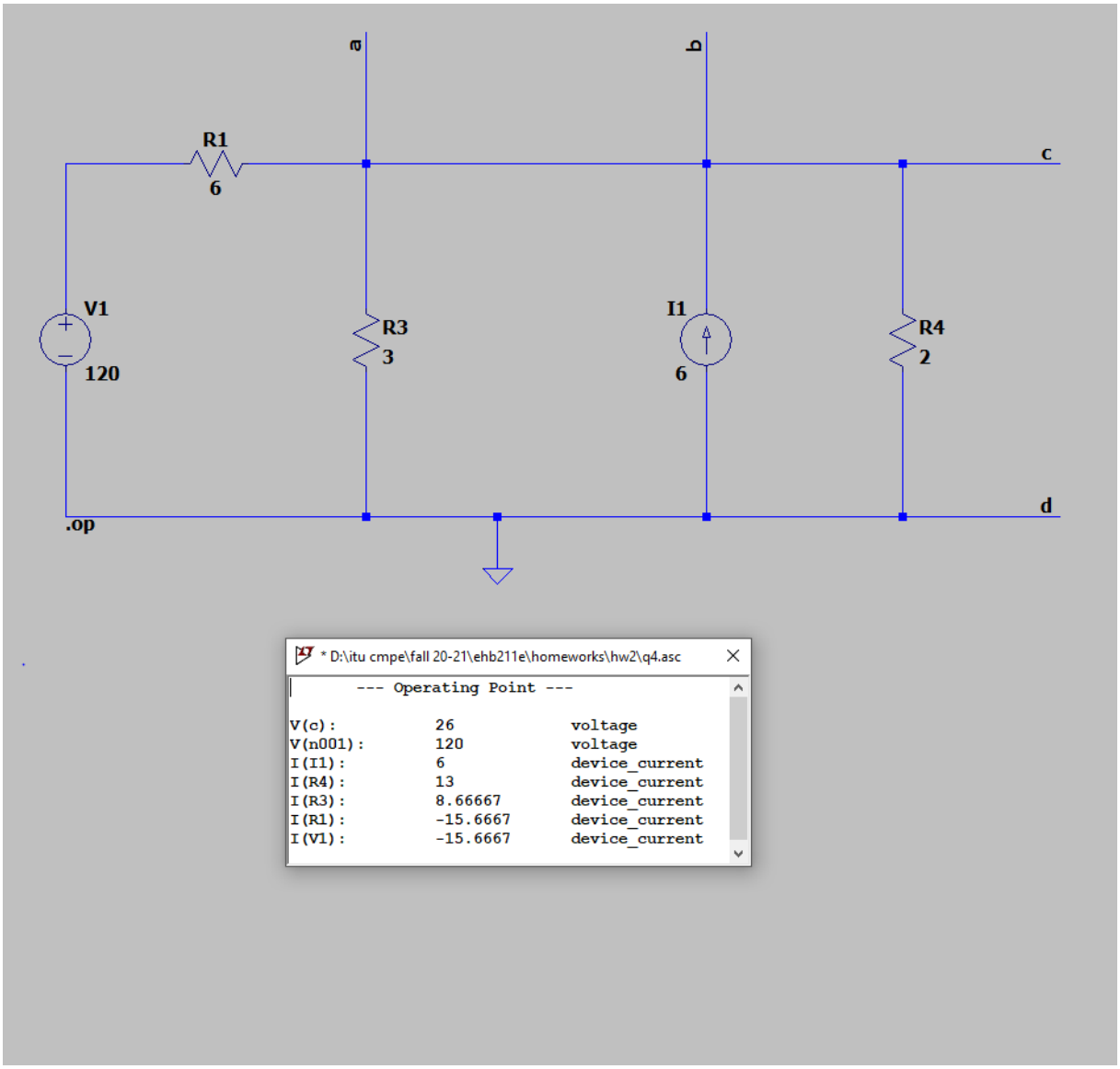


$$R_N = (2\Omega + 4\Omega) \,//\, 2\Omega$$

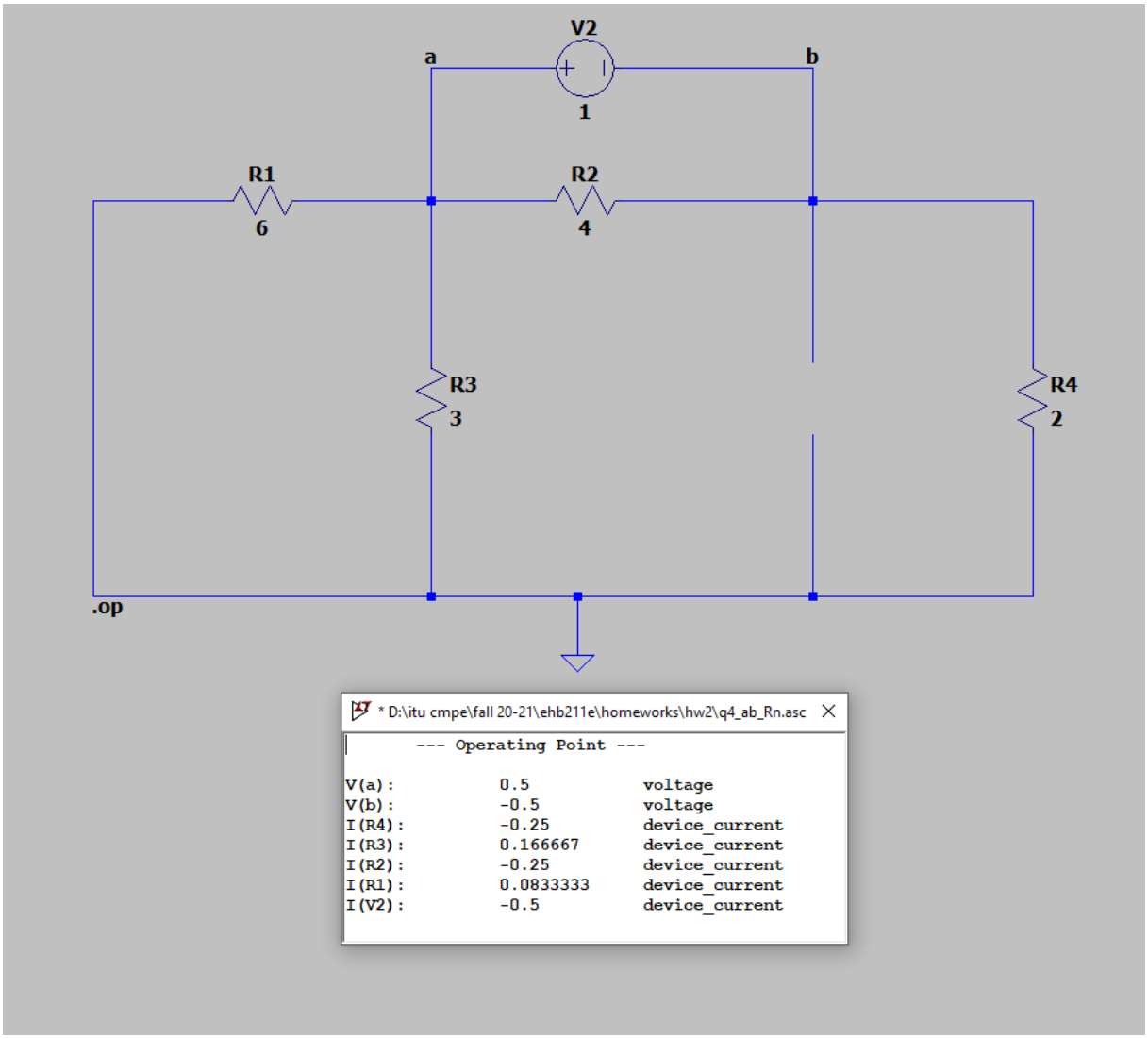
$$R_N = \frac{6 \cdot 2}{6 + 2} = \frac{3}{2}\Omega$$

$$\boxed{R_N = 1,5\Omega}$$

Q4 simulation:



Q4 simulation according a-b: RN



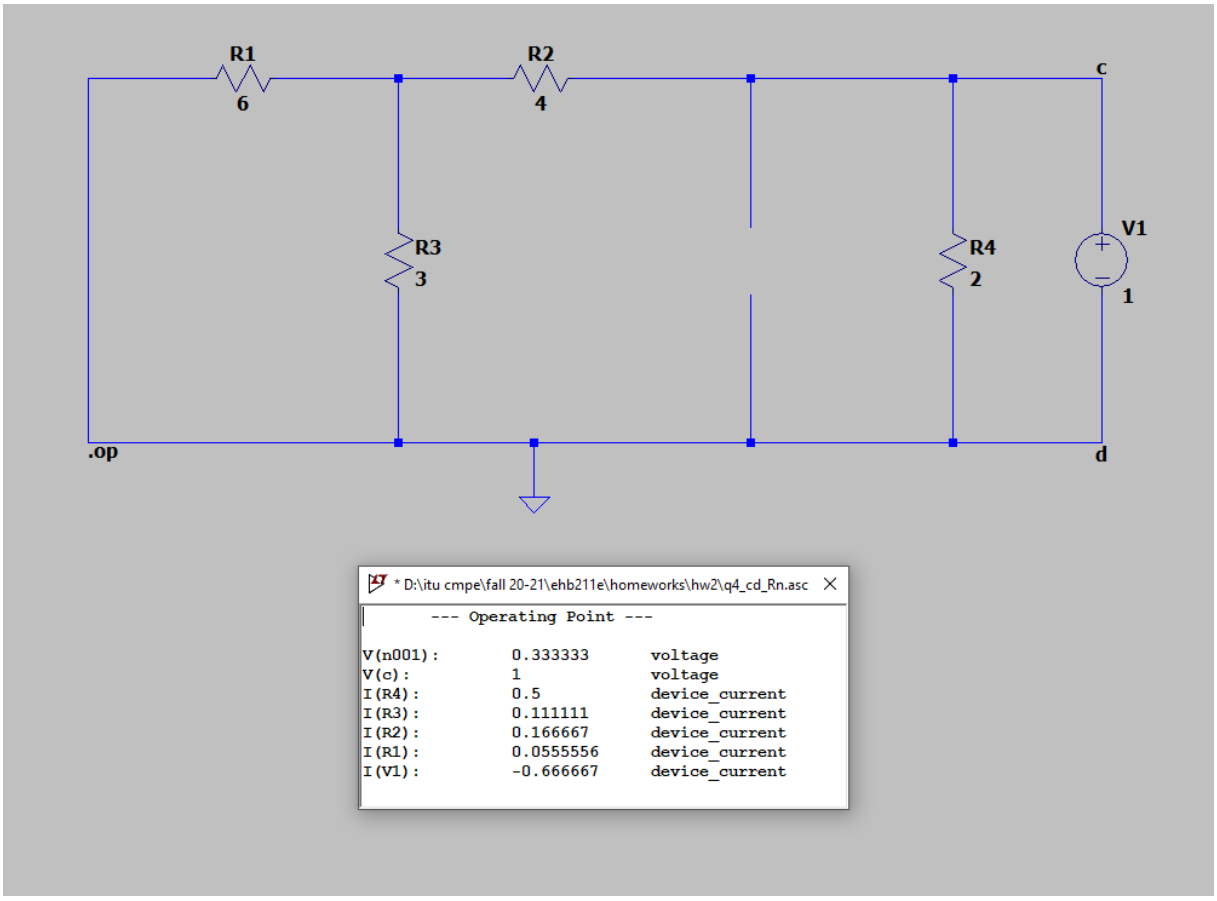
current flows through V2 = 0.5A

V2 = 1V

1V = 0.5A * RN

RN = 2 ohm

Q4 simulation according c-d: RN



current flows through V1 = 0.666667A

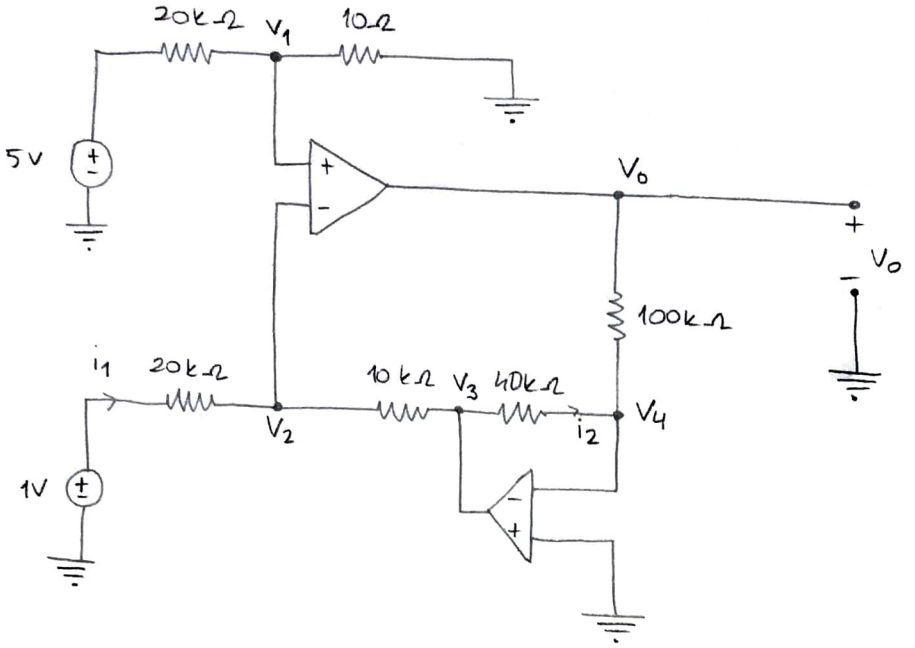
V1 = 1V

1V = 0.666667A * RN

RN = 1.5 ohm

Ömer Malik Kalembaşı
150180112

Q5.



$V_1 = V_2$ $\qquad V_1 = \frac{5V}{3}$ $\qquad$ so $\qquad V_2 = \frac{5V}{3}$

$V_4 = 0$

$$i_1 = \frac{1 - V_2}{20k\Omega} = \frac{1 - \frac{5}{3}}{20k\Omega} \Rightarrow i_1 = \frac{-1}{30}\ mA$$

$$V_2 - V_3 = i_1 \cdot 10k\Omega = \frac{-1}{3}\ V$$

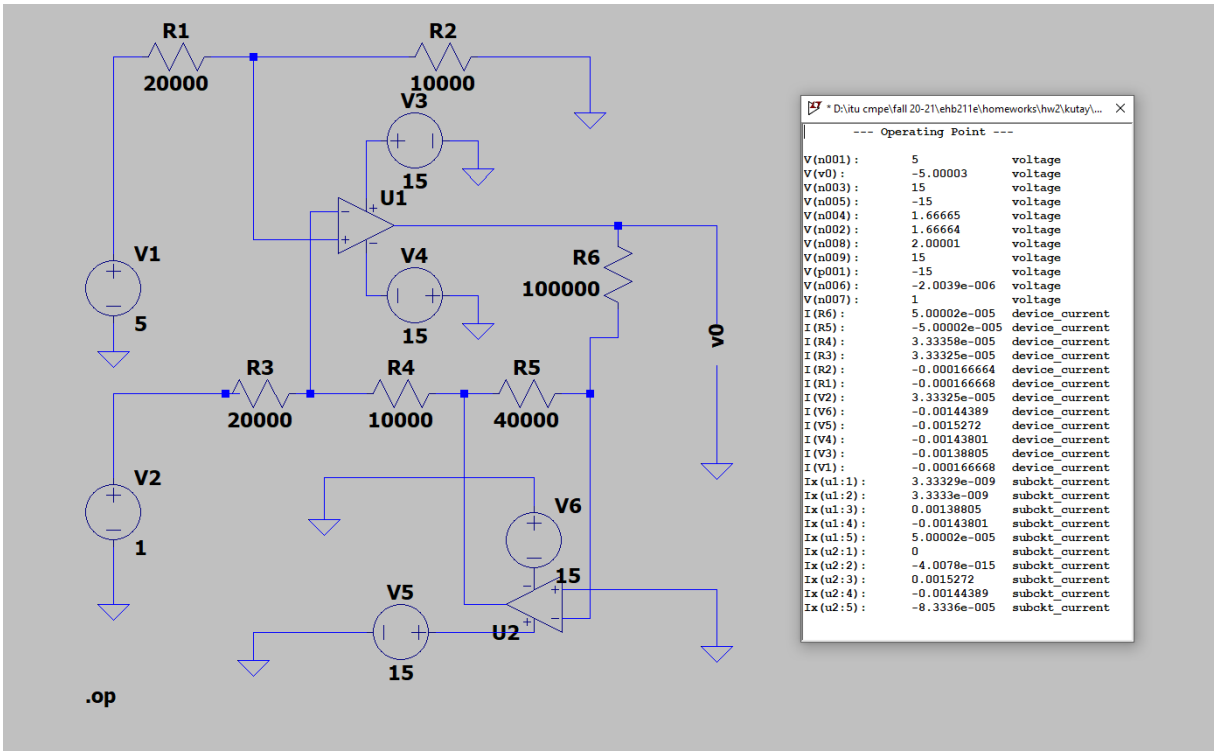
$$V_3 = V_2 + \frac{1}{3} = \frac{5}{3} + \frac{1}{3} = 2V$$

$$i_2 = \frac{V_3 - V_4}{40k\Omega} = \frac{2-0}{40k\Omega} \qquad i_2 = \frac{1}{20}\ mA$$

$$V_o = -i_2 \cdot 100k\Omega$$

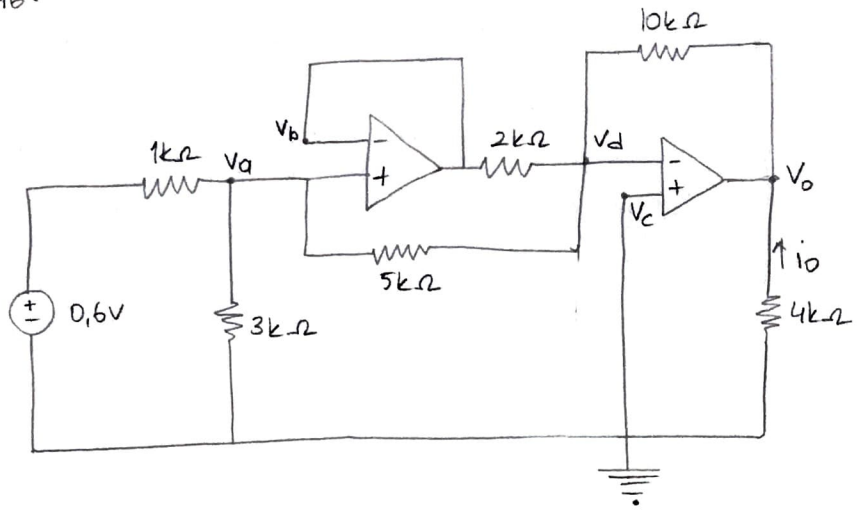
$$\boxed{V_o = -5\ V}$$

Q5 simulation:



Ömer Malik Kalembaşı
150180112

Q6.



$V_a = V_b$ $\qquad V_a = \frac{0,6 \cdot 3}{4} = 0,45\ V$

$V_c = V_d = 0$ $\qquad V_b = 0,45\ V$

KCL from V_d:

$$\frac{V_d - V_a}{2} + \frac{V_d - V_a}{5} + \frac{V_d - V_o}{10} = 0 \quad , \quad V_d = 0$$

$$\frac{-V_a}{2} - \frac{V_a}{5} - \frac{V_o}{10} = 0$$

$$\frac{V_o}{10} = \frac{-0,45}{2} - \frac{0,45}{5}$$

$$V_o = -13,5\ V$$

$$i_o = \frac{-V_o}{4k\Omega} = \frac{13,5}{4000\Omega}$$

$$\boxed{i_o = 3,375\ mA}$$