Attribution Nidhal Abdulaziz

Lecture 5 additional solutions

Superposition Theorem

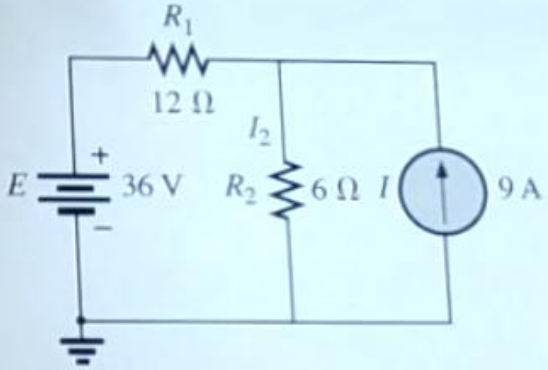
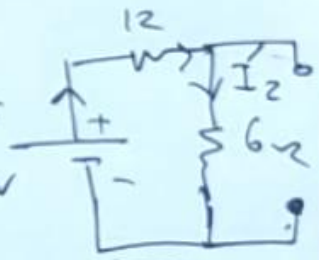
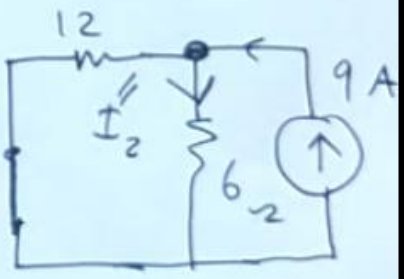


FIG. 9.2 *Network to be analyzed in Example 9.1 using the superposition theorem.*

$$I_2' = \frac{36V}{12+6} = 2A \downarrow$$

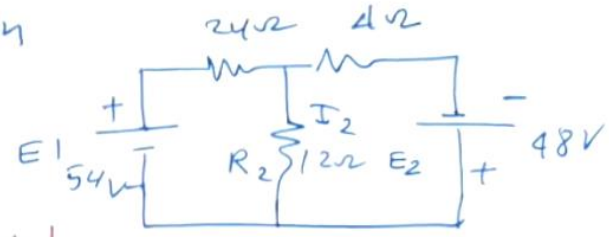


$$I_2'' = 9A \times \frac{12}{12+6} = 6A \downarrow$$



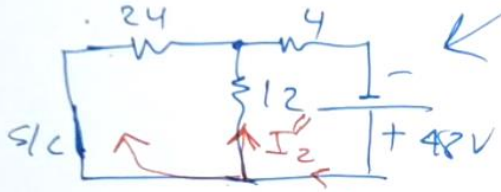
$$I_2 = I_2' + I_2'' = 8A \downarrow$$

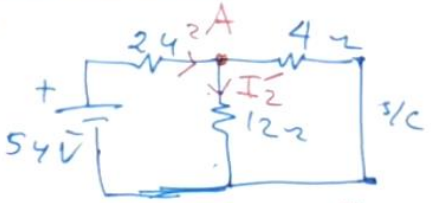
Lecture 5 Superposition



$$I_t = \frac{54V}{24\Omega} = 2A$$

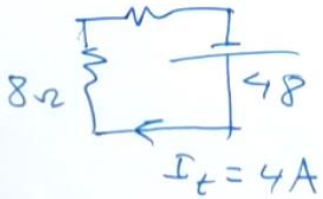
$$I_2' = 2A \times \frac{4}{4+12} = 0.5A \downarrow$$

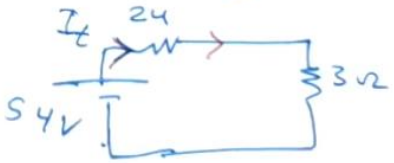




$$I_2'' = 4 \times \frac{24}{24+12} =$$

$$= 2.6A \uparrow$$



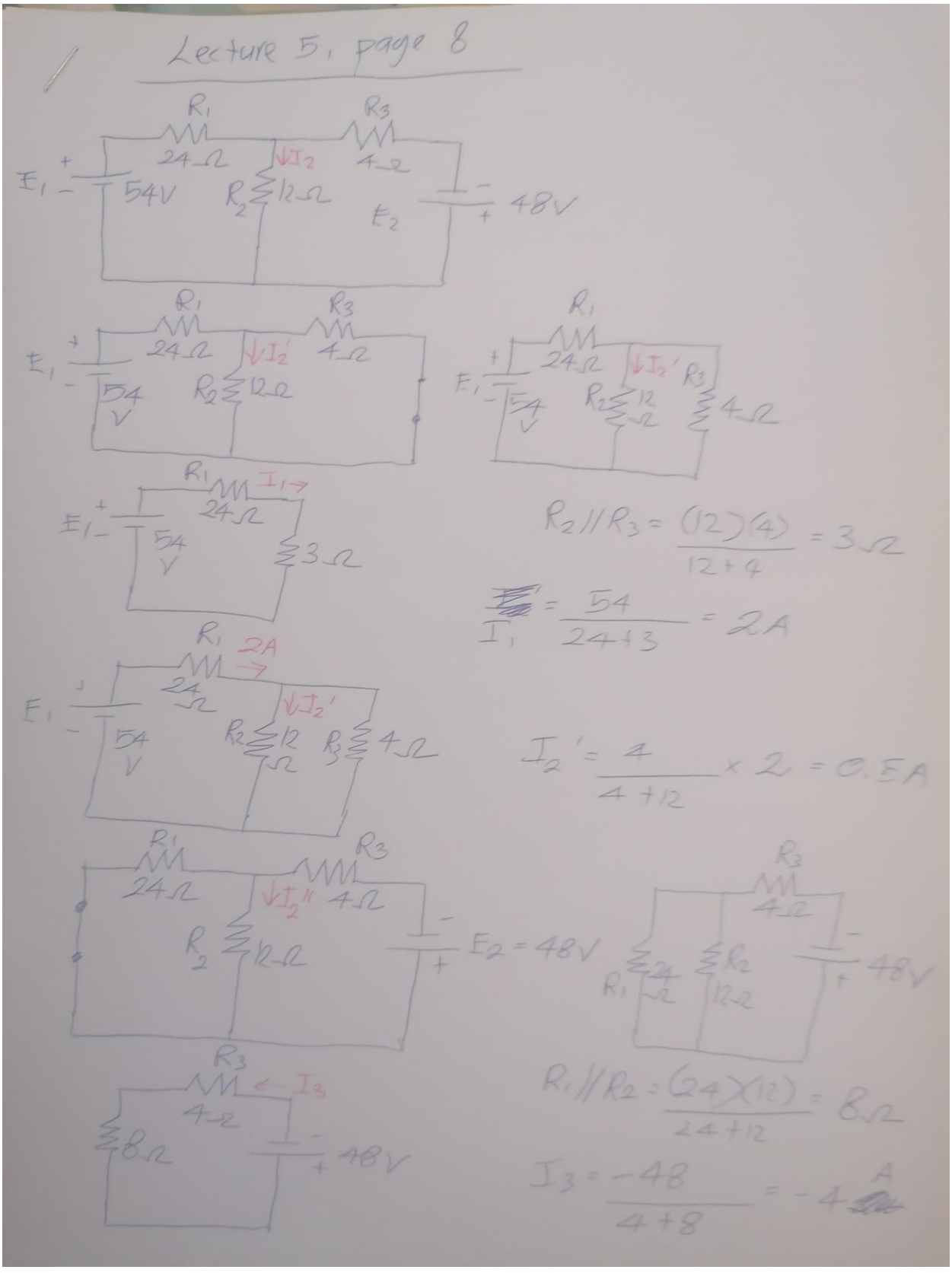


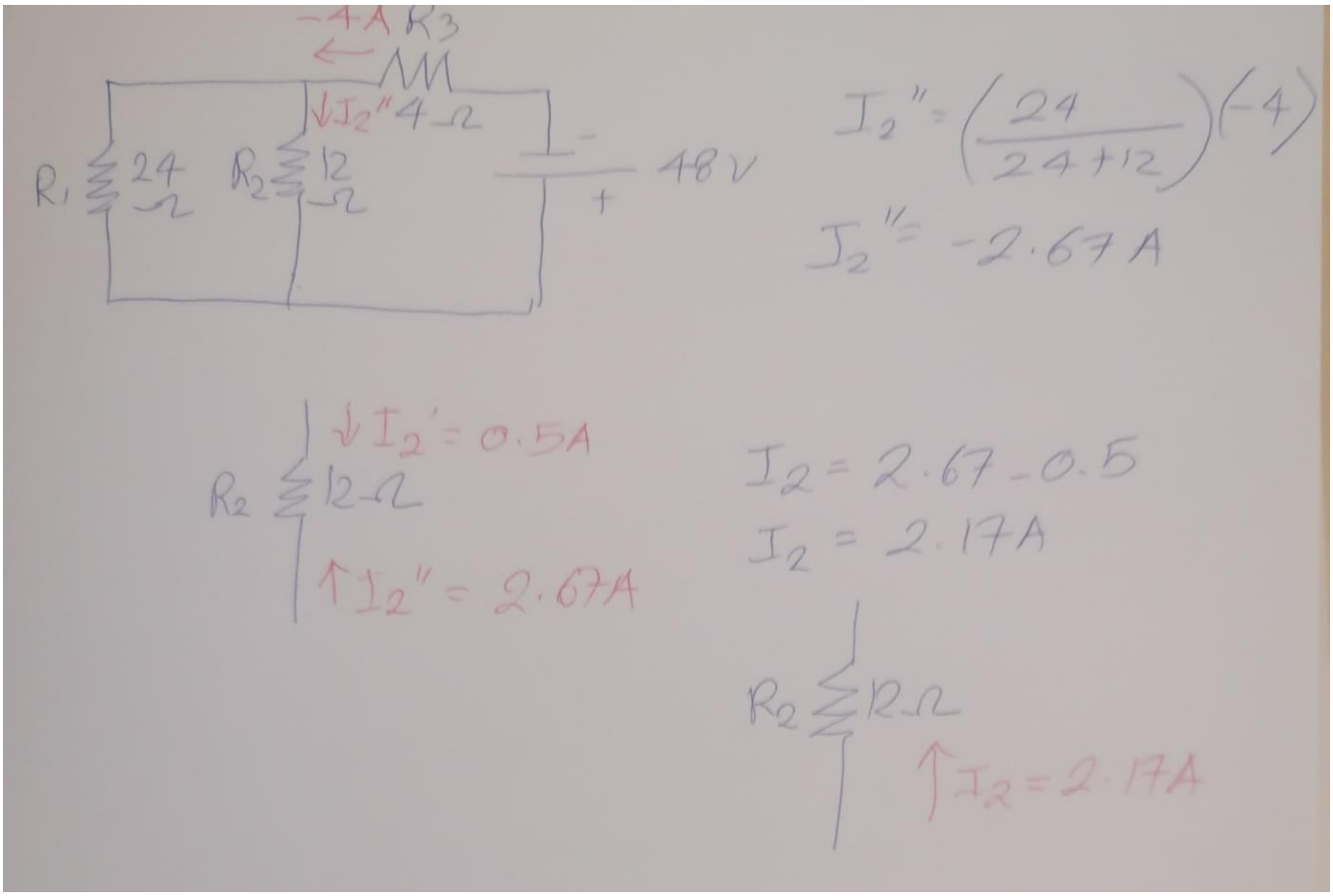
$$I_t = 4A$$

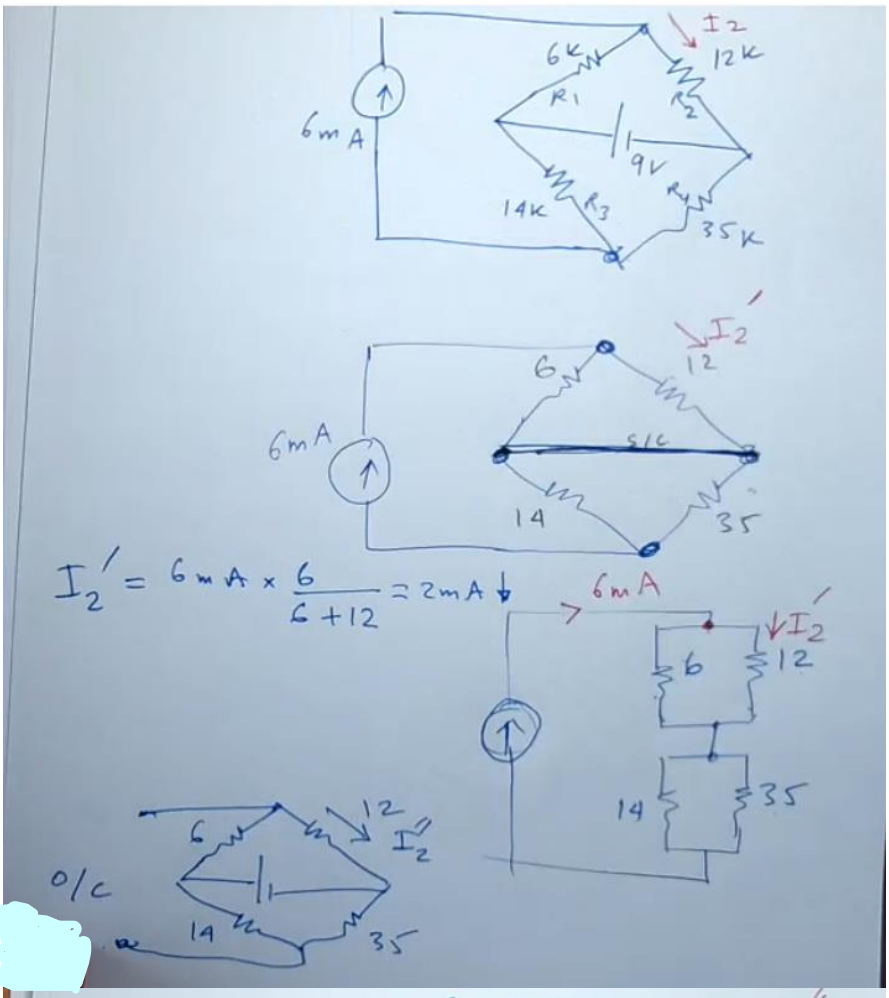
$$I_2 = 2.6 - 0.5$$

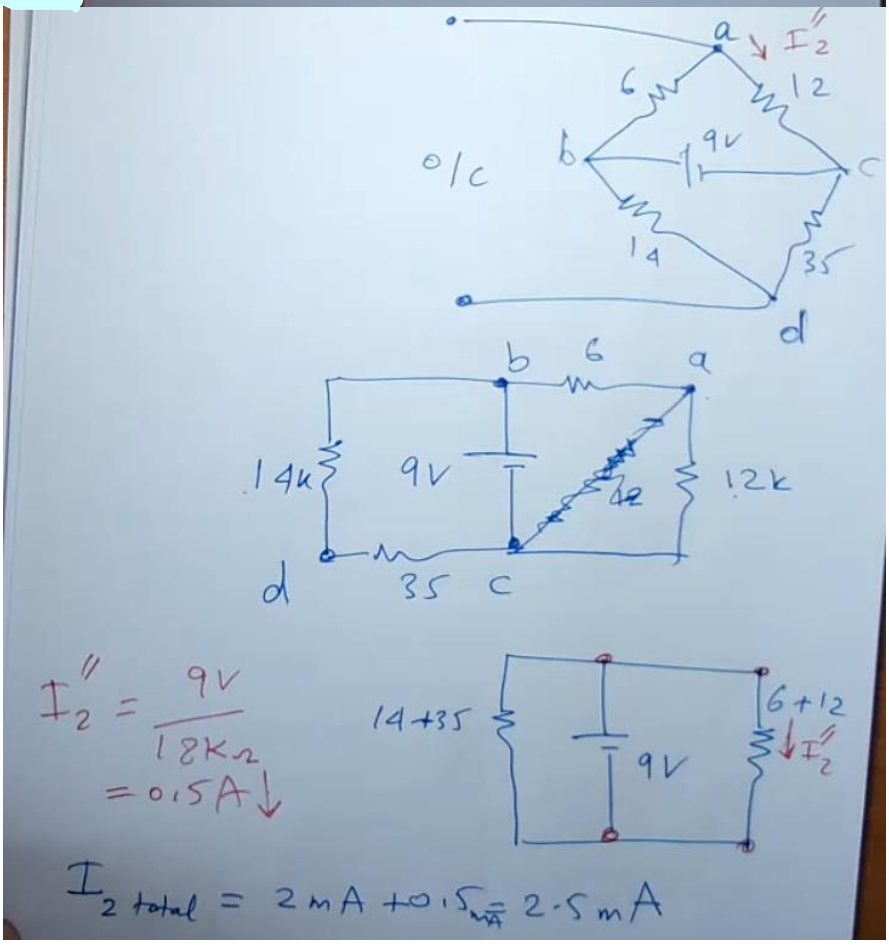
$$= 2.1A \uparrow$$

OR

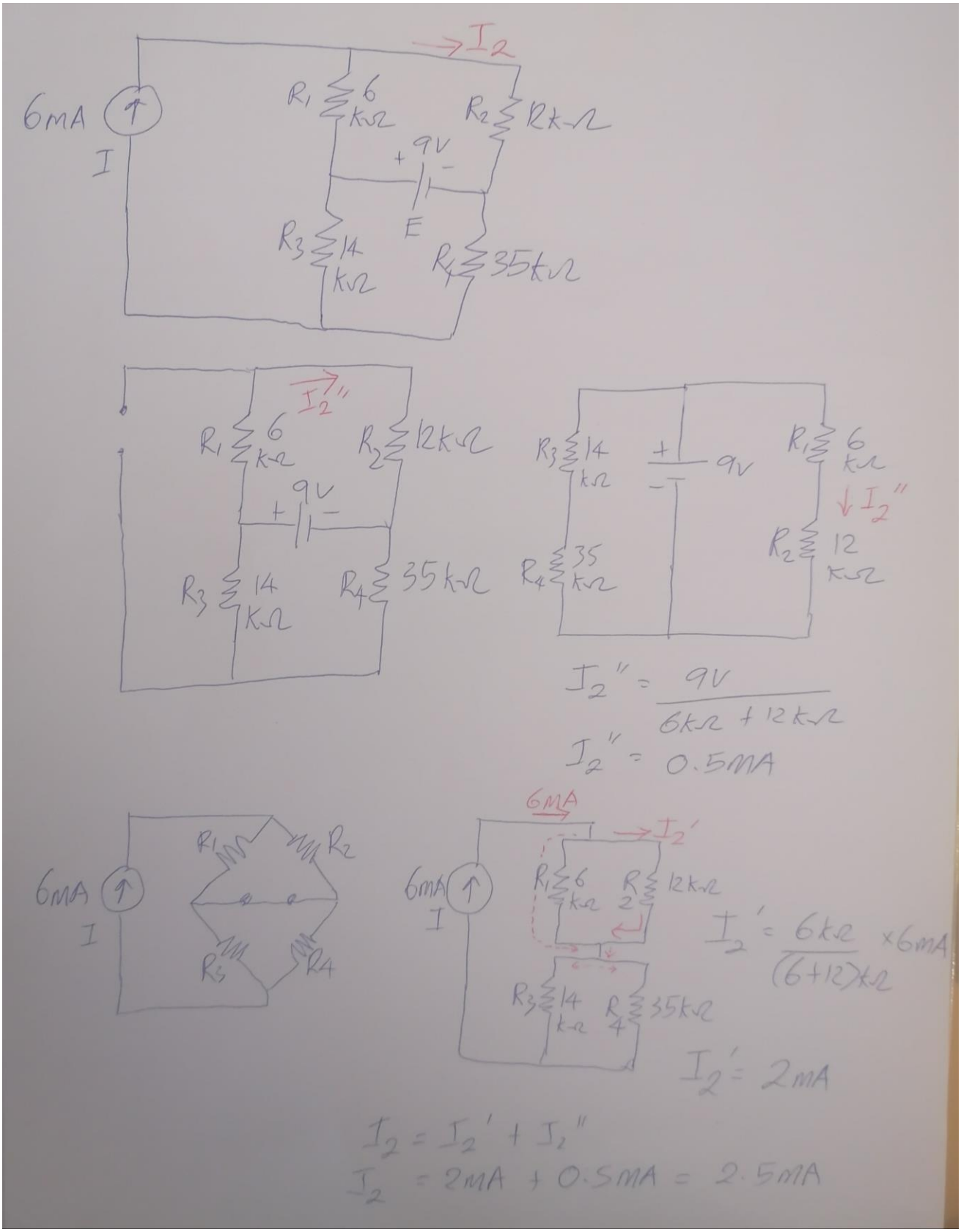

Lecture 5, page 8
R1
24Ω
R3
4Ω
I2
E1
54V
R2
12Ω
E2
48V
I2'
54 V
I1
3Ω
2A
R2 // R3 = (12)(4)/(12+4) = 3Ω
I1 = 54/(24+3) = 2A
I2' = 4/(4+12) x 2 = 0.5A
I2''
8Ω
I3
-48/(4+8) = -4A


-4A R3
↓I2" 4Ω
R1 24Ω
R2 12Ω
48V
-
+
I2" = (24/24+12)(-4)
I2" = -2.67A
↓I2' = 0.5A
R2 12Ω
↑I2" = 2.67A
I2 = 2.67 - 0.5
I2 = 2.17A
R2 12Ω
↑I2 = 2.17A


6mA
6K
R1
12K
R2
9V
14K
R3
35K
I2
6mA
6
12
14
35
I2'
I2' = 6mA × 6/(6+12) = 2mA ↓
6mA
6
12
14
35
I2'
o/c
6
12
14
35
I2''


a
I2''
6
12
o/c
b
9V
c
14
35
d
b
6
a
14k
9V
12k
d
35
c
I2'' = 9V / 18kΩ = 0.5A ↓
14+35
9V
6+12
I2''
I2 total = 2mA + 0.5mA = 2.5mA

OR


6mA
I
R1 6 kΩ
R2 12kΩ
9V
E
R3 14 kΩ
R4 35kΩ
I2
I2''
I2' = 6kΩ / (6+12)kΩ × 6mA
I2'' = 9V / 6kΩ + 12kΩ
I2'' = 0.5mA
I2' = 2mA
I2 = I2' + I2''
I2 = 2mA + 0.5mA = 2.5mA

Thevenin

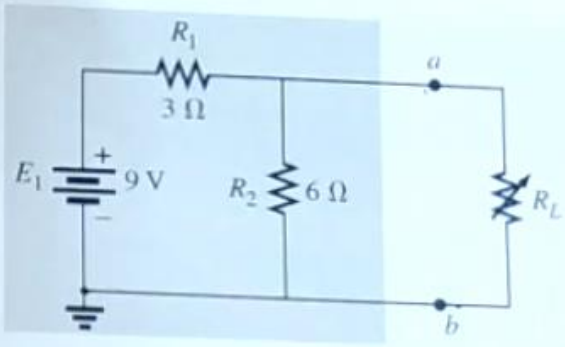
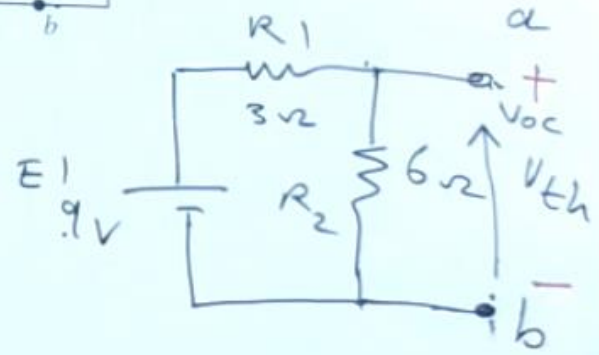
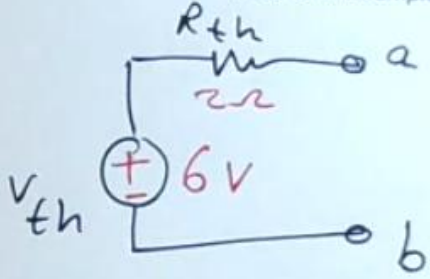


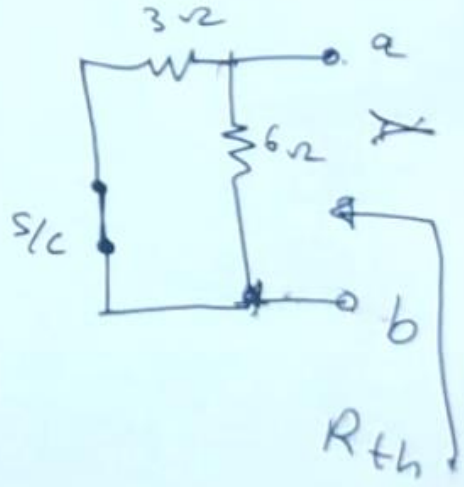
FIG. 9.26 *Example 9.6.*

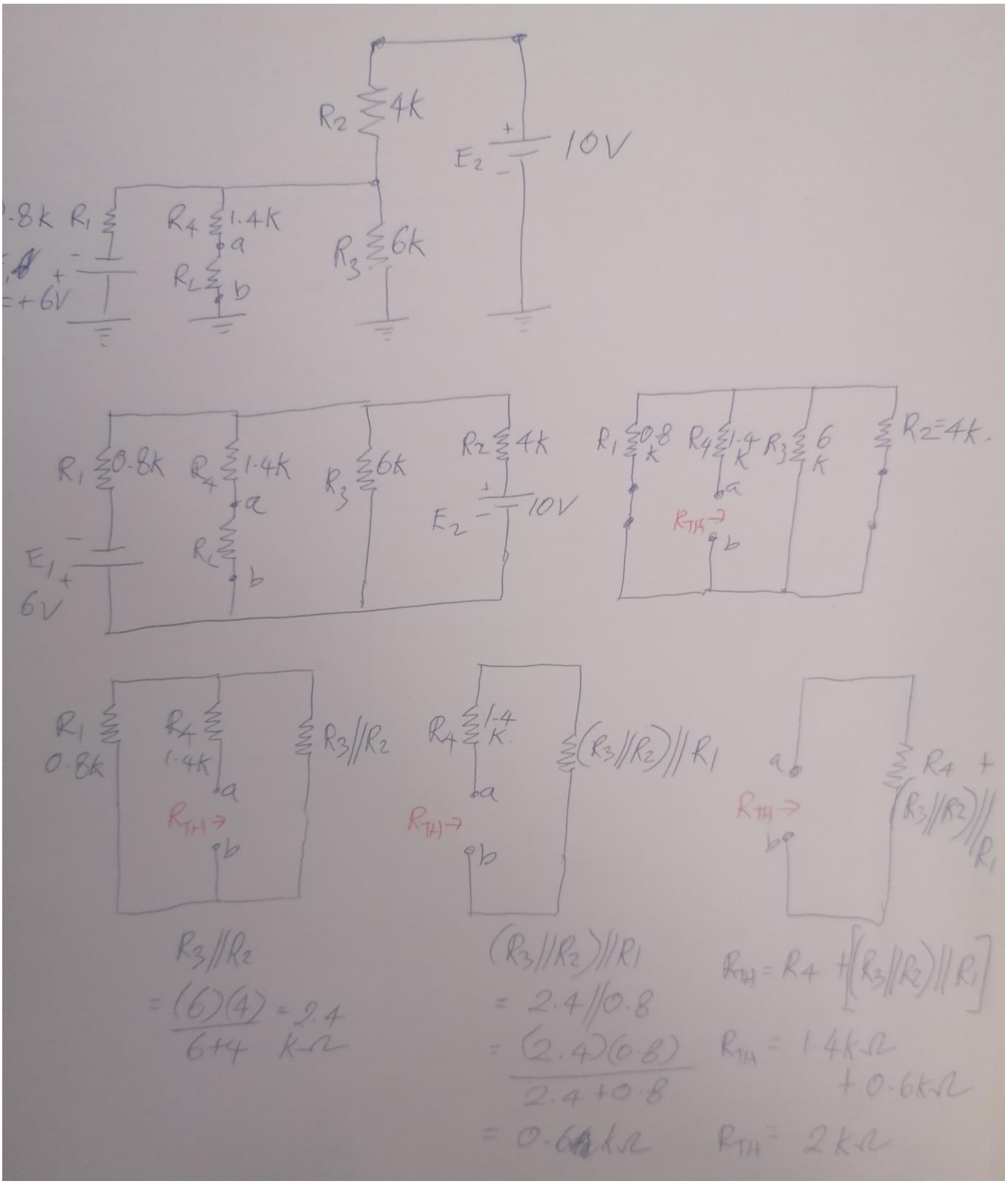




$$R_{th} = \frac{3 \times 6}{3+8} = 2\,\Omega$$

$$V_{th} = 9V \times \frac{6}{3+6} = 6V$$





$R_3 // R_2$

$= \frac{(6)(4)}{6+4} = 2.4$ kΩ

$(R_3 // R_2) // R_1$

$= 2.4 // 0.8$

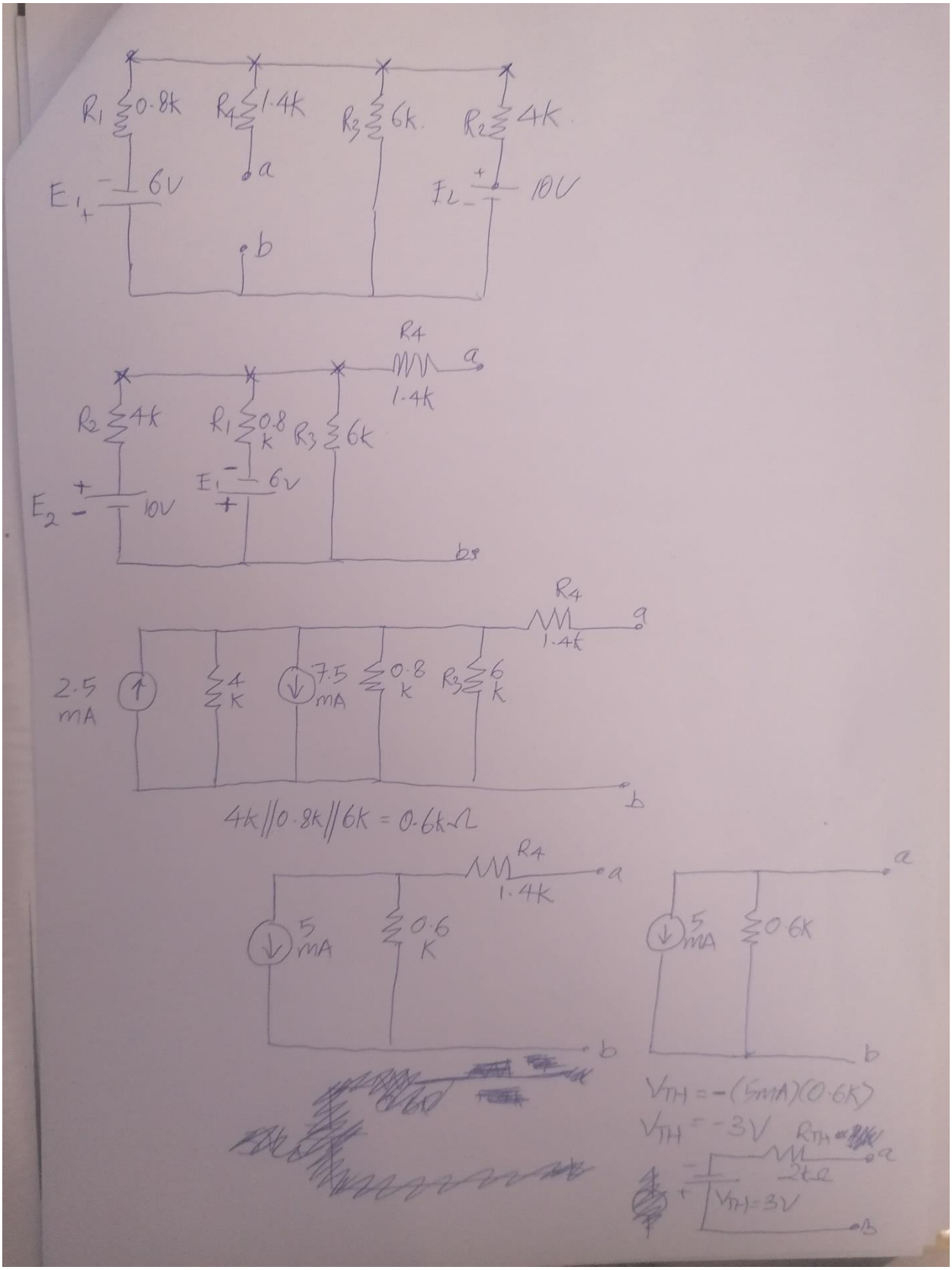
$= \frac{(2.4)(0.8)}{2.4+0.8}$

$= 0.6$ kΩ

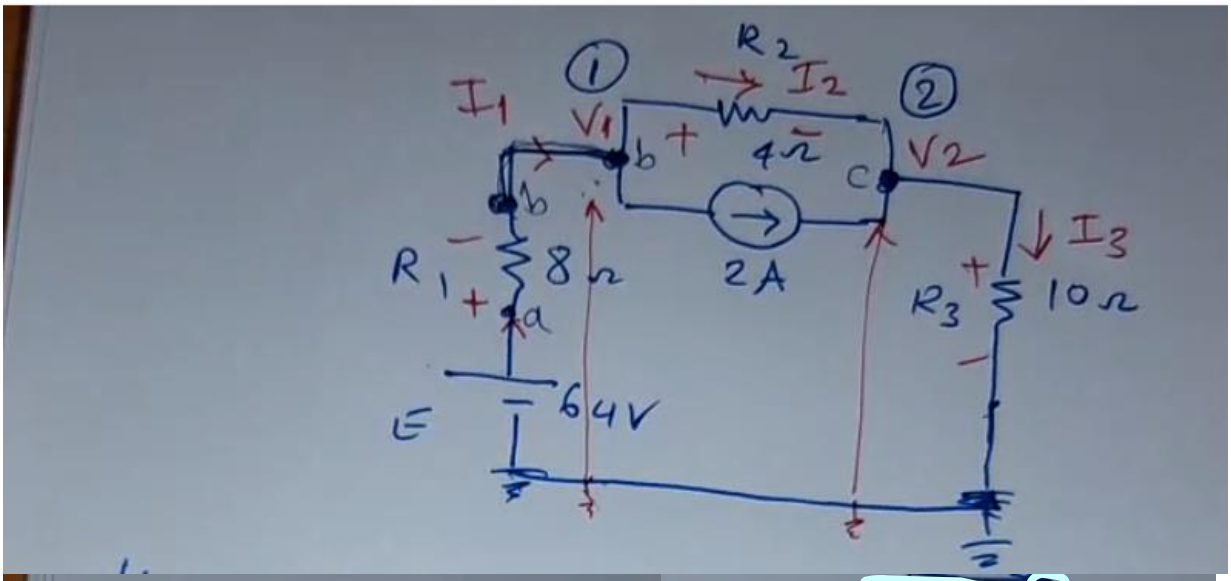
$R_{TH} = R_4 + [(R_3 // R_2) // R_1]$

$R_{TH} = 1.4\text{k}\Omega + 0.6\text{k}\Omega$

$R_{TH} = 2\text{k}\Omega$


R1 0.8k
R4 1.4k
R3 6k
R2 4k
E1 6V
E2 10V
a
b
R4 1.4k
R2 4k
R1 0.8 k
R3 6k
E1 6V
E2 10V
2.5 mA
4 K
7.5 mA
0.8 k
6 K
4k//0.8k//6K = 0.6k-Ω
5 mA
0.6 K
0.6K
VTH = -(5mA)(0.6K)
VTH = -3V
RTH
2kΩ
VTH=3V

Additional example (This question is not included in lecture 5 slides)



KCL node (1)

$I_1 = I_2 + 2A$ — (1)

KCL node (2)

$I_2 + 2A = I_3$ — (2)

$\frac{64 - V_1}{8} = \frac{V_1 - V_2}{4} + 2A$ — (1)

$\frac{V_1 - V_2}{4} + 2A = \frac{V_2}{R_3}$ — (2)

$I_1 = \frac{V_{R_1}}{R_1} = \frac{V_{ab}}{R_1}$

$I_1 = \frac{V_a - V_b}{R_1}$

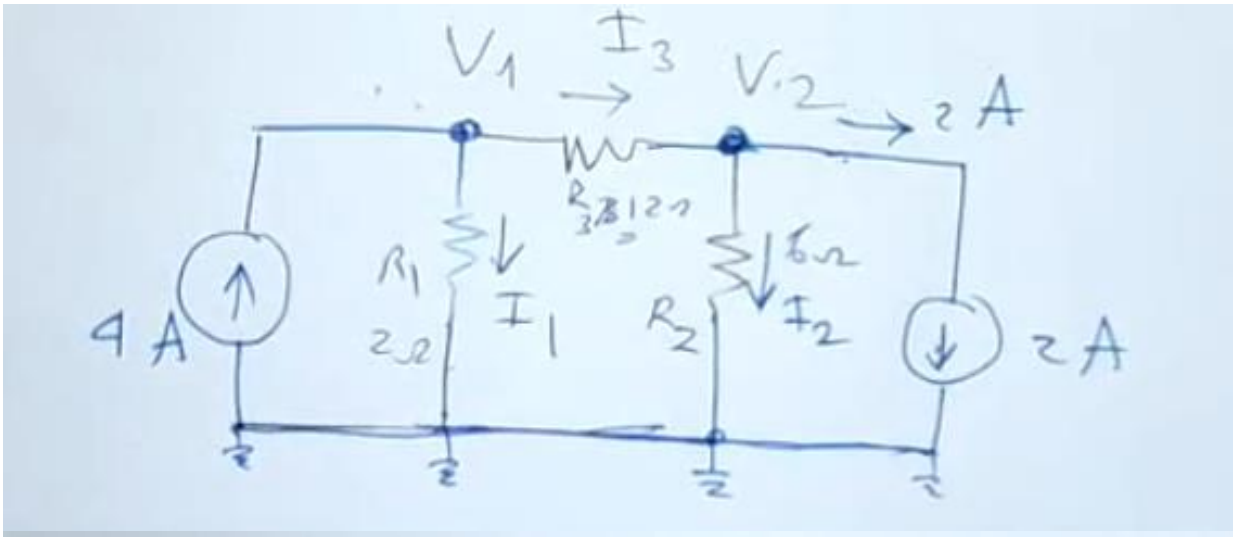
$I_1 = \frac{E - V_1}{R_1}$

$I_2 = \frac{V_{R_2}}{R_2} = \frac{V_{bc}}{R_2}$

$I_2 = \frac{V_1 - V_2}{R_2}$

$I_3 = \frac{V_{R_3}}{R_3} = \frac{V_2}{R_3}$

Another example (This question is not included in Lecture 5 slides)



KCL ①

$4A = I_1 + I_3$ — ①

KCL ②

$I_3 = 2A + I_2$ — ②

$I_1 = \frac{V_{R_1}}{R_1} = \frac{V_1}{R_1}$

$I_2 = \frac{V_2}{R_2}$

$I_3 = \frac{V_1 - V_2}{R_3}$

$4 = \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_3}$ — ①

$\frac{V_1 - V_2}{R_3} = 2 + \frac{V_2}{R_3}$ — ②