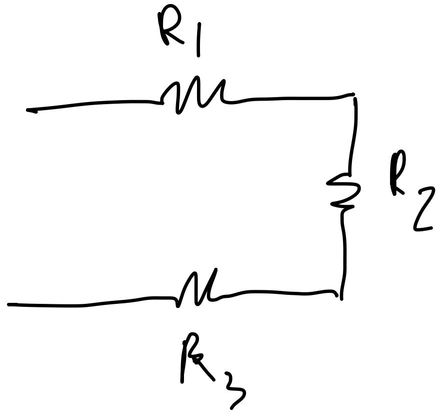
Quiz 1: Nhat Ho

Problem 1:

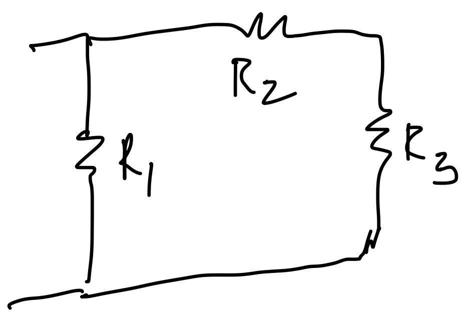
a)

i)



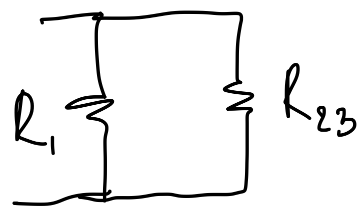
$$\Rightarrow \boxed{R_{eq} = R_1 + R_2 + R_3}$$

ii)



R_2 series $R_3 \Rightarrow R_{23} = R_2 + R_3$

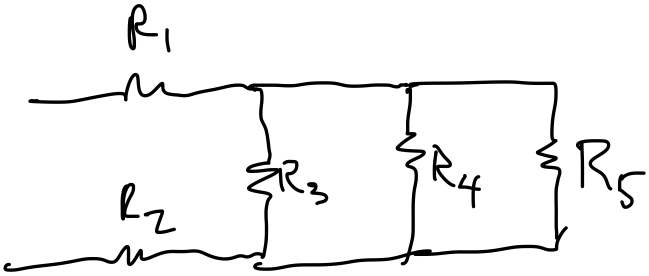
$\Leftrightarrow$



$R_{23} = R_2 + R_3$

Since $R_1 \parallel R_{23} \Rightarrow R_{eq} = \dfrac{R_1 R_{23}}{R_1 + R_{23}} = \boxed{\dfrac{R_1(R_2+R_3)}{R_1+R_2+R_3}}$

iii)



$R_4 \parallel R_5 \Rightarrow R_{45} = \dfrac{R_4 R_5}{R_4 + R_5}$

$R_3 \parallel R_{45} \Rightarrow R_{345} = \dfrac{R_3 R_{45}}{R_3 + R_{45}}$

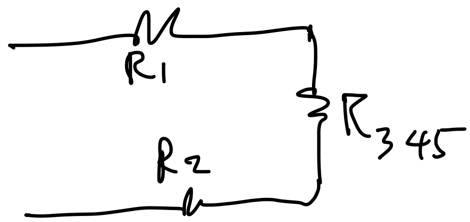
We have: $R_3 R_{45} = R_3 \dfrac{R_4 R_5}{R_4 + R_5} = \dfrac{R_3 R_4 R_5}{R_4 + R_5}$

$$R_3 + R_{45} = R_3 + \frac{R_4 R_5}{R_4 + R_5} = \frac{R_3 R_4 + R_3 R_5}{R_4 + R_5}$$

$$\Rightarrow R_{345} = \frac{R_3 R_4 R_5}{R_4 + R_5} \cdot \frac{R_4 + R_5}{R_3 R_4 + R_3 R_5}$$

$$= \frac{R_3 R_4 R_5}{R_3 R_4 + R_3 R_5}.$$

Also:



$$\Rightarrow R_{eq} = R_1 + R_{345} + R_2$$

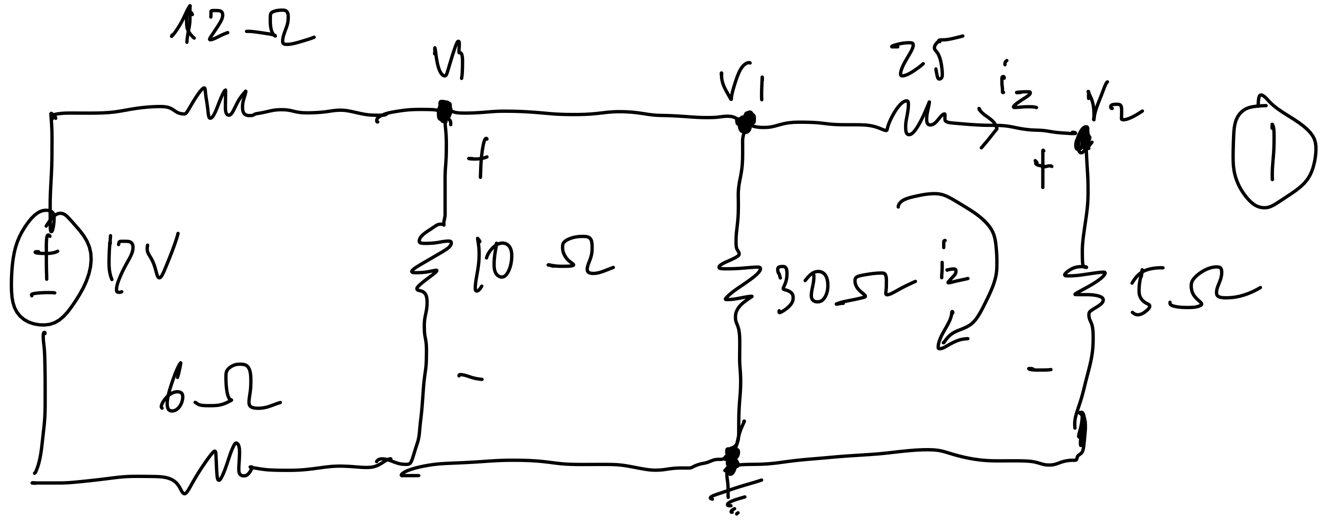
$$= \frac{R_3 R_4 R_5}{R_3 R_4 + R_3 R_5} + R_1 + R_2$$

$$= \frac{R_3 R_4 R_5 + (R_1 + R_2)(R_3 R_4 + R_3 R_5)}{R_3 R_4 + R_3 R_5}$$

$$= \boxed{\frac{R_3 R_4 R_5 + R_1 R_3 R_4 + R_1 R_3 R_5 + R_2 R_3 R_4 + R_2 R_3 R_5}{R_3 R_4 + R_3 R_5}}$$

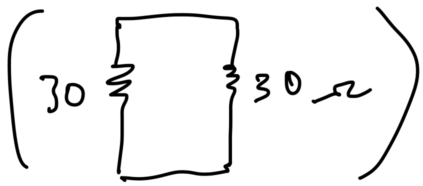
b) I will do 1b later

c)

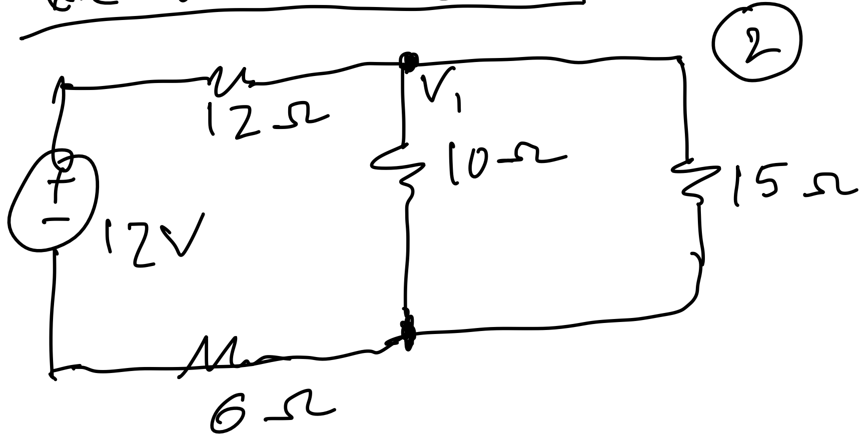


We have (25 Ω series 5 Ω) then parallel with 30 Ω

$\Rightarrow R_{25-5} = 25 + 5 = 30\ \Omega$

$\Rightarrow R_{30-25-5} = \dfrac{30 \times 30}{30 + 30} = 15\ \Omega$ 

$\Rightarrow$ We have new circuit:

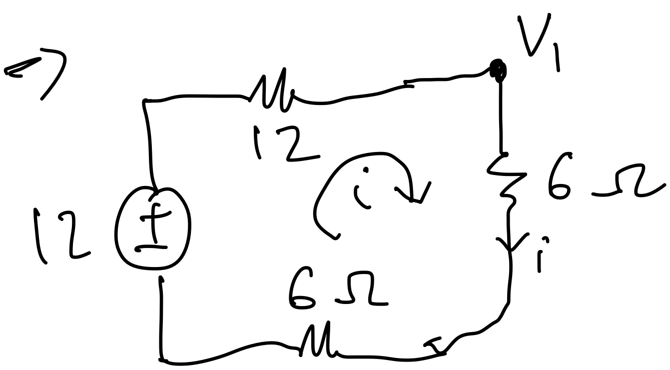


Since 10 Ω ∥ 15 Ω

$\Rightarrow R_{10-15} = \dfrac{15 \times 10}{15 + 10}$

$\Rightarrow R_{10-15} = 6\ \Omega$

$\Rightarrow$



Apply KVL, we have:

$12 = (12 + 6 + 6)\, i = 24 i$

$\Rightarrow i = \dfrac{12}{24} = 0.5\ A$

Also, $V_1 = 6i \Rightarrow \boxed{V_1 = 6 \times 0.5 = 3\ (V)}$

Go back to circuit 1, we have

$25 i_2 + 5 i_2 = V_1 = 3V$ (Apply KVL)

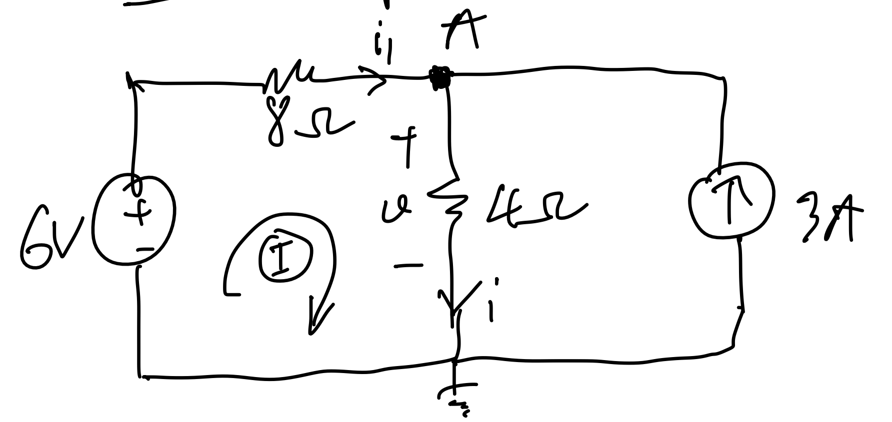
$\Rightarrow 30 i_2 = 3V \Rightarrow i_2 = \frac{3}{30} = 0.1 (A)$

$\Rightarrow V_2 = 5 i_2 = 5 \times 0.1 = 0.5V$

$\Rightarrow \boxed{V_2 = 0.5V}$

Problem 2:

a) Find voltage:



Apply KCL at A,

$i_1 + 3 = i$

Apply KVL for loop I,

$6 = 8i_1 + 4i \Rightarrow 8i_1 + 4(i_1+3) = 6$

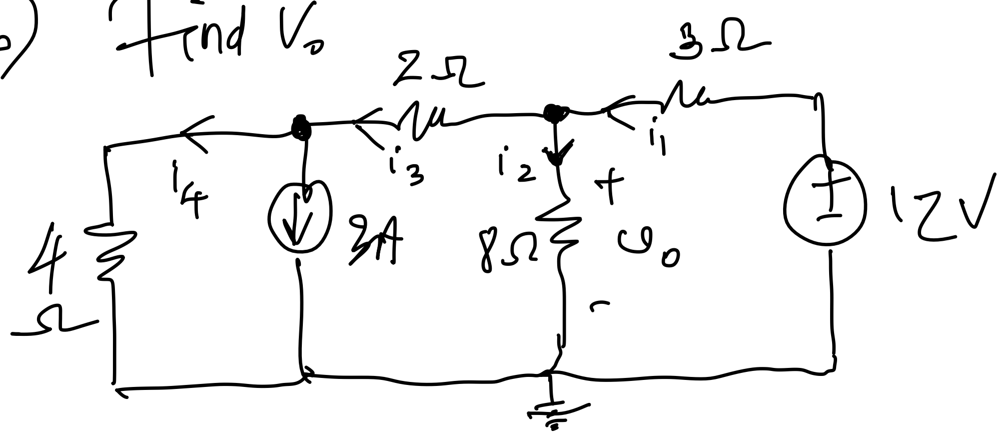
$\Rightarrow 12i_1 + 12 = 6 \Rightarrow i_1 = -0.5\,(A)$

$\Rightarrow i = i_1 + 3 = -0.5 + 3 = 2.5\,A$

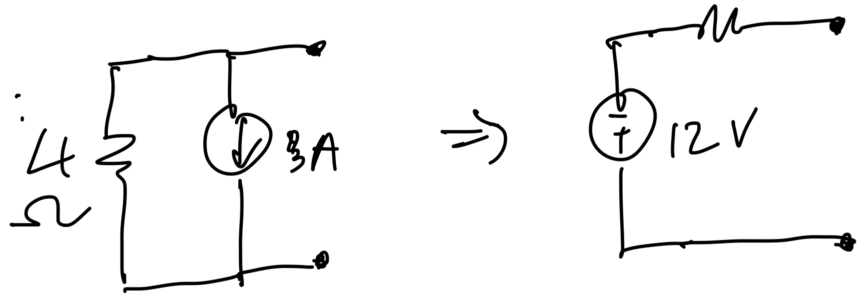
$\Rightarrow v = i \cdot 4\Omega = 2.5 \times 4 = 10V$

$\Rightarrow \boxed{v = 10V}$

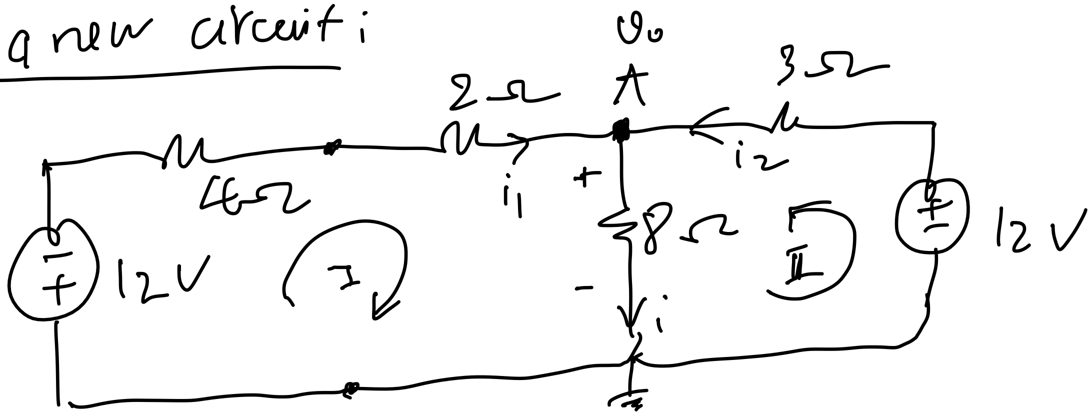
b) Find V_o



We have:



⇒ a new circuit:



Apply KCL at A, $i_1 + i_2 = i$ (1)

Apply KVL for I, we have:

$$12 + 6i_1 + 8i = 0 \Rightarrow 6i_1 + 8i = -12 \quad (2)$$

Apply KVL for II, we have:

$$-12 + 3i_2 + 8i = 0 \Rightarrow 3i_2 + 8i = 12 \quad (3)$$

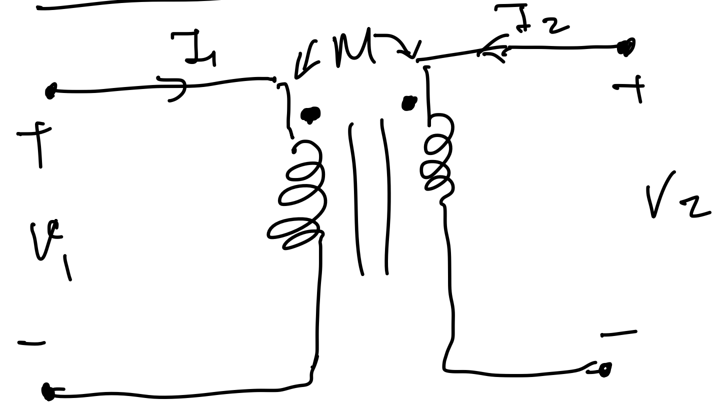
From (1), (2), & (3), we have:

$$\begin{cases} i_1 + i_2 - i = 0 \\ 6i_1 + 0i_2 + 8i = -12 \\ 0i_1 + 3i_2 + 8i = 12 \end{cases} \Rightarrow \begin{cases} i_1 = -38/15\ A \\ i_2 = 44/15\ A \\ i = 0.4\ A \end{cases}$$

$$\Rightarrow v_0 = 8i = 8 \times 0.4 = \boxed{3.2\ V}$$

Problem 37

a) Ideal transformer:



b) Given $N_p = N_1$, ratio n, find $N_s = N_2$

We have $n = \frac{N_2}{N_1} = \frac{N_s}{N_p} \Rightarrow \boxed{N_s = n N_p}$

c) $V_p = V_1$, $\Rightarrow V_s = V_2 = \frac{N_2}{N_1} V_1$

$$\Rightarrow \boxed{V_s = \frac{N_s}{N_p} V_p}$$

Since $V_s = L \frac{di_s}{dt} + M \frac{di_p}{dt} \Rightarrow V_s$ depend on I_s

d) We have $i_2 = \frac{N_1}{N_2} i_1 \Rightarrow \boxed{I_s = \frac{N_p}{N_s} I_p}$

e) $P_s = V_s I_s$

$P_p = V_p . I_p$

$\Rightarrow$ efficiancy (e) $= \frac{P_p}{P_s} = \frac{V_s I_s}{V_p I_p}$

$$e = \frac{N_s}{N_p} \cdot \frac{N_p}{N_s} = 1 \Leftrightarrow \text{ideal transformer}$$

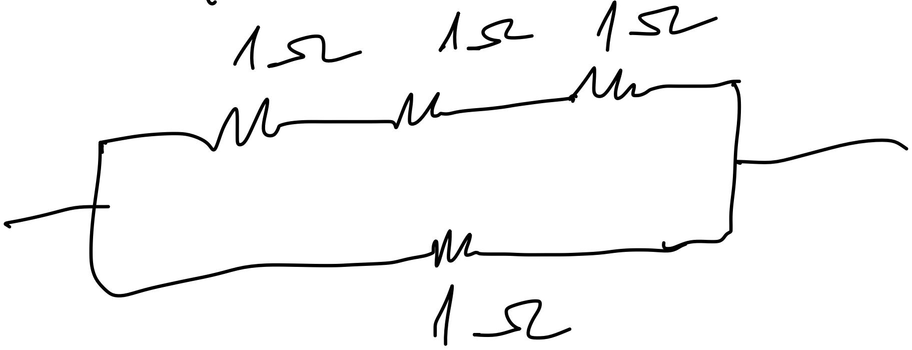
f) When the coins have resistence, then

$$R_1 = \left(\frac{N_1}{N_2}\right)^2 R_2$$

Problem 1b:

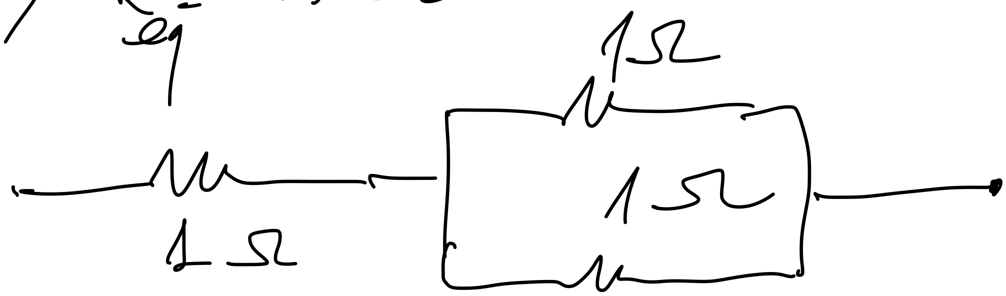
$R = 1\,\Omega$

i) $R_{eq} = 0.75$



$\Rightarrow R_{eq} = 0.75\,(\Omega)$

ii) $R_{eq} = 1.5\,\Omega$



$\Rightarrow R_{eq} = 1 + 0.5 = 1.5\,\Omega$