กลุ่มวด เฉลยข้อสอบ กลางภาค. ทฤษฎีวงจรไฟฟ้า

เทอม 1 ๒๕๕๘.

① หา R_T ที่จุด A-B

$R_{T1} = 2 + 2.5 = 4.5\ \Omega$

$R_{T2} = 7 + 5 = 12\ \Omega$

$R_{T3} = R_{T1} \,//\, R_{T2} = \dfrac{4.5 \times 12}{4.5 + 12} = 3.272\ \Omega$

$R_{T4} = R_{T3} \,//\, 12\ \Omega = \dfrac{3.272 \times 12}{3.272 + 12} = 2.571\ \Omega$

$R_{T5} = 9\ \Omega \,//\, R_{T4} = \dfrac{9 \times 2.571}{9 + 2.571} = 2.00\ \Omega$

$R_{T6} = R_{T5} + 2 + 2 = 2.00 + 4 = 6.0\ \Omega$

$R_{T7} = 6 \,//\, 6 \,//\, R_{T6} = 6 // 6 // 6 = 2\ \Omega$

$R_{T8} = 2\ \Omega + 7\ \Omega = 9\ \Omega$

$R_{T9} = 9\ \Omega \,//\, R_{T8} = \dfrac{9 \times 9}{9 + 9} = 4.5\ \Omega$

$R_{T10} = 4.5 + 2.5 = 7\ \Omega$

$R_{T11} = 7\ \Omega \,//\, 5\ \Omega = \dfrac{7 \times 5}{7 + 5} = 2.916\ \Omega$

$R_T = 2.916 + 1 + 12 = 15.916\ \Omega$ — Ans

(2) Η R_T συνάρτηση A-D

$R_{T1} = 10 // 10 = 5\Omega$

$R_{T2} = 10 // 10 = 5\Omega$

$R_{T3} = R_{T1} + R_{T2} = 5+5 = 10\Omega$

$R_{T4} = 10 // 10 = 5\Omega$

$R_{T5} = 10 // 10 = 5\Omega$

$R_{T6} = R_{T4} + R_{T5} = 5+5 = 10\Omega$

$R_{T7} = R_{T3} // R_{T6} = 10 // 10\ \Omega$

$R_{T7} = 5\Omega$

$R_{T7} = R_{A-D} = 5\Omega$ ——— Ø

———

(1) en I_T , I_1 , I_2

$R_{T1} = 1.5 // 3\,\Omega = 1\,\Omega$

$R_{T2} = 1 + 2.8 + 1 = 4.8\,\Omega$

$R_{T3} = 7.5 // R_{T2} = \dfrac{7.5 \times 4.8}{7.5 + 4.8} = 2.926\,\Omega$

$R_{T4} = R_{T3} // 5\,\Omega = \dfrac{2.926 \times 5}{2.926 + 5} = 1.8463\,\Omega$

$R_{T5} = R_{T4} // 8\,\Omega = \dfrac{1.8463 \times 8}{1.8463 + 8} = 1.5\,\Omega$

$R_T = 0.5 + 1.5 + 1 = 3\,\Omega$

$I_T = \dfrac{E}{R_T} = \dfrac{6}{3} =$ (2 A) ——

$V_{R\,8\Omega} = E - I_T \times 0.5 - I_T \times 1$

$V_{R\,8\Omega} = 6 - (2 \times 0.5 + 2 \times 1) = 6 - 3 = 3\,V$

$V_{R\,5\Omega} = V_{R\,8\Omega} = 3\,V$

$I_1 = \dfrac{3\,V}{5\,\Omega} =$ (0.6) A ——

$$I_0 = \frac{I_T \times 8}{8 + R_{T4}} = \frac{I_T \times 8}{8+1}$$

$$I_0 = \frac{2 \times 8}{8 + 1.8463} = 1.6249 \text{ A}$$

$$I_1 = \frac{I_0 \times R_{T3}}{5 + R_{T3}} = \frac{1.6249 \times 2.426}{5 + 2.426}$$

$$I_1 = 0.559 \simeq 0.6 \text{ A}$$

$$V_{R_{7.5}\Omega} = V_{R_{4.8}\Omega} = V_{R_{7.5}\Omega} = 3V$$

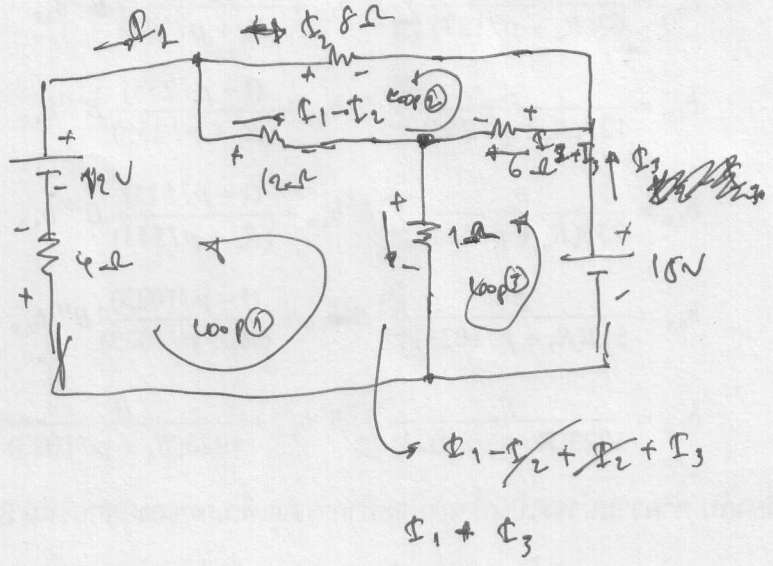
$$I_{R_{7.5}} = \frac{3}{7.5} = 0.4 \text{ A}$$

$$I_{R_{4.8}\Omega} = \frac{3}{R_{T2}} = \frac{3}{4.8} \text{ A} \doteq 0.625 \text{ A}$$

$$I_2 = \frac{I_{R_{7.5}} \times 1.5}{3 + 1.5} = \frac{0.625 \times 1.5}{3+1.5}$$

$$I_2 = \boxed{0.208} \text{ A}$$

(4)



Loop ① KVL

$$+4I_1 - 12 + 12(I_1 - I_2) + 1(I_1 + I_3) = 0$$

$$4I_1 - 12 + 12I_1 - 12I_2 + I_1 + I_3 = 0$$

$$17I_1 - 12I_2 + I_3 = 12 \quad \text{——— (1)}$$

Loop ②

$$+12(I_1 - I_2) - 6(I_3 + I_2) - 8I_2 = 0$$

$$12I_1 - 12I_2 - 6I_3 - 6I_2 - 8I_2 = 0$$

$$12I_1 - 26I_2 - 6I_3 = 0 \quad \text{——— (2)}$$

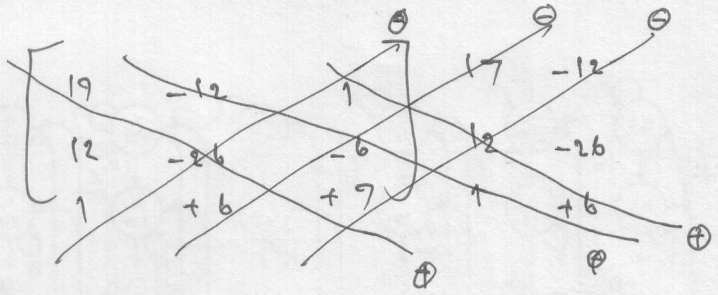
Loop ③

$$-15 + 6(I_2 + I_3) + 1(I_1 + I_3) = 0$$

$$-15 + 6I_2 + 6I_3 + I_1 + I_3 = 0$$

$$I_1 + 6I_2 + 7I_3 = 15 \quad \text{——— (3)}$$

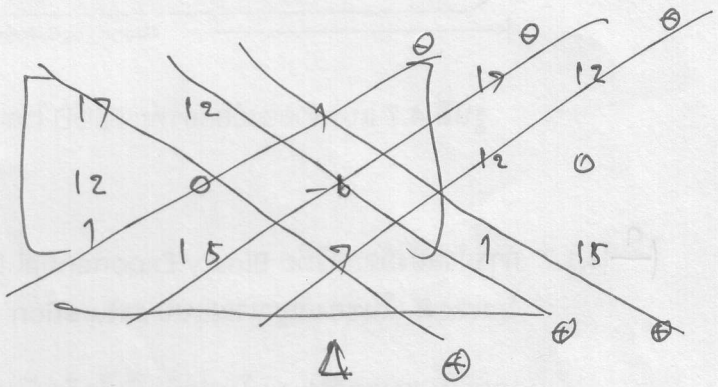
Δ =



$= -3044 + 72 + 72 + 26 + 612 + 1008$

$\Delta = -1304$

$\Phi = \Phi_2 =$



$$\Phi = \frac{0 - 72 + 180 - 0 + 1530 - 1008}{-1304}$$

$$\Phi = \frac{630}{-1304} = -0.483 \text{ A}$$

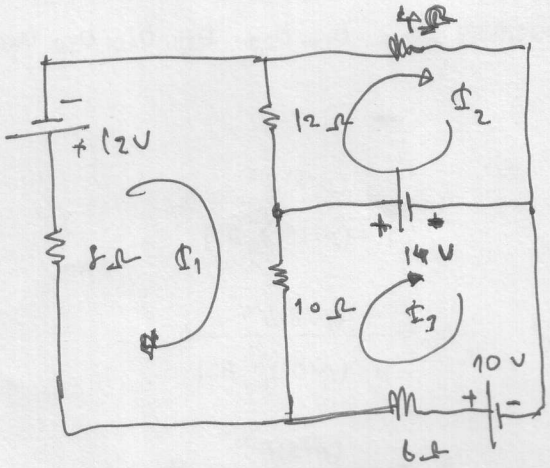
(7)

$I_2 = 0.148$ A — ผ่าน 10 Ω

$I_1 = 0.942$ A — ผ่าน

$V_x = 9.83$ V — คร่อม 12 Ω

(5) ใช้ mesh



loop I_1

$$(8+10+12)I_1 - 12I_2 - 10I_3 = -12$$

$$30I_1 - 12I_2 - 10I_3 = -12 \quad \text{——— (1)}$$

loop I_2 *

$$16I_2 - 12I_1 = 14$$

$$-12I_1 + 16I_2 = 14 \quad \text{——— (2)}$$

loop I_3

$$16I_3 - 10I_1 = -14 + 10$$

$$-10I_1 + 16I_3 = -4 \quad \text{——— (3)}$$

$$\Delta = \begin{vmatrix} 30 & -12 & -10 \\ -12 & 16 & 0 \\ -10 & 0 & 16 \end{vmatrix} \begin{matrix} 30 & -12 \\ -12 & 16 \\ -10 & 0 \end{matrix}$$

$= 7680 - 1600 - 2304$

$= 3776$

$$I_1 = \frac{\begin{vmatrix} -12 & -12 & -10 \\ 14 & 16 & 0 \\ -4 & 0 & 16 \end{vmatrix} \begin{matrix} -12 & -12 \\ 14 & 16 \\ -4 & 0 \end{matrix}}{3{,}776}$$

$$I_1 = \frac{-3072 + 0 + 0 - 640 - 0 + 2688}{3{,}776} = \frac{-1028}{3776} = -0.2711 \text{ A}$$

$$I_2 = \frac{\begin{vmatrix} 30 & -12 & -10 \\ -12 & 14 & 0 \\ -10 & -4 & 16 \end{vmatrix} \begin{matrix} 30 & -12 \\ -12 & 14 \\ -10 & -4 \end{matrix}}{3776}$$

$$I_2 = \frac{+6720 + 0 - 480 - 1400 - 0 - 2304}{3{,}776} = \frac{2576}{3{,}776}$$

~~$I_2 = 0.671$~~

$$I_2 = 0.671 \text{ A}$$

ตามกฎ แครมเมอร์ I_1 ไหลกลับทิศทาง

I ที่ไหลผ่าน $R_{12\,\Omega} = I_1 + I_2 = 0.2711 + 0.671$

I_2 I ผ่าน $R_{12\,\Omega} = 0.9421$ A — ตอบ

แล้ว $I_3 = \frac{\begin{vmatrix} 30 & -12 & -12 \\ -12 & 16 & 14 \\ -10 & 0 & -4 \end{vmatrix} \begin{matrix} 30 & -12 \\ -12 & 16 \\ -10 & 0 \end{matrix}}{3{,}776} =$

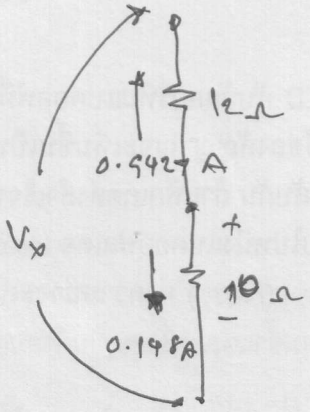
$$I_3 = \frac{-1920 + 1680 + 0 - 1920 - 0 + 576}{3,796} = \frac{-1584}{3796}$$

$I_3 = -0.419$ แสดงว่า I_3 ไหลสวนทิศที่สมมติ

$\therefore I_{R_{10\Omega}} = I_3 - I_1 = 0.419 - 0.2711$ A

I_2 $I_{R_{10\Omega}} = 0.148$ A

หา V_x



$V_{R_{12\Omega}} = 0.5429 \times 12 = 11.3129$ V

$V_{R_{10\Omega}} = 0.148 \times 10 = 1.48$ V

$V_x = V_{R_{12\Omega}} - V_{R_{10\Omega}} = 11.3129 - 1.48$

V_x $V_x = 9.83$ V

(b) หา node voltage ที่ V_1, V_2, V_3

เห็นว่า $V_1 = 1\ A$

~~$I_2 = 0.5\ A$~~

~~$I_3 = 0.5\ A$~~

ดังนั้น $V_A = 6\ V$ → เพราะขนานกับแหล่งจ่าย

Node A →

$$I_5 = I_1 + I_3 \quad \text{——— (1)}$$

$$I_1 = \frac{V_A - (-6)}{12} = \frac{V_A + 6}{12}$$

$$I_1 = \frac{6+6}{12} = \frac{12}{12} = 1\ A \quad \text{——— (2)}$$

Node B

$$I_5 + I_2 = I_4$$

$$\frac{V_A - V_B}{2} + \frac{0-(-6)-V_B}{8} = \frac{(V_B - 1)}{4}$$

$$\frac{6 - V_B}{1} + \frac{6}{8} = \frac{V_B - 1}{4} = \frac{V_B}{4} - \frac{1}{4}$$

$$6 - V_B + 0.75 = \frac{V_B}{4} - \frac{1}{4}$$

$$6 + 0.75 + 0.25 = 0.25V_B + V_B$$

$$7 = (0.25 + 1)V_B = 1.25\ V_B$$

Node B

$$I_3 + I_2 = I_4$$

$$\frac{V_A - V_B}{2} + \frac{6 - V_B}{8} = \frac{V_B - 1}{4}$$

$$\frac{V_A}{2} - \frac{V_B}{2} + \frac{6}{8} - \frac{V_B}{8} = \frac{V_B}{4} - \frac{1}{4}$$

$$0.5 V_A - 0.5 V_B + 0.75 - 0.75 V_B = 0.25 V_B - 0.25$$

$$V_A = 6V$$

$$0.5(6) + 0.75 + 0.25 = 0.5 V_B + 0.75 V_B + 0.25 V_B$$

$$4 = 1.5 V_B$$

$$V_B = \frac{4}{1.5} = 2.666 V$$

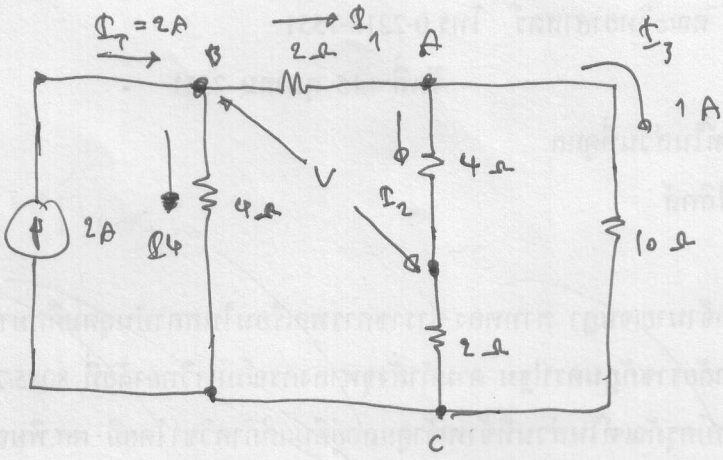
$$I_2 = \frac{6 - V_B}{8} = \frac{6 - 2.666}{8} = \underline{0.416\ A}$$

$$I_3 = \frac{V_A - V_B}{2} = \frac{6 - 2.666}{2} = \underline{1.667\ A}$$

$V = 3$ V. (ตามโจทย์)

(7) หา V.

เขียนรูปใหม่



จากรูปที่ 1 $I_3 = 1$ A

$$V_{R_{10}} = 1 \times 10 = 10V$$

$$I_2 = \frac{V_{R_{10}}}{6} = \frac{10}{6} = 1.666 \text{ A}$$

$$I_1 = I_2 + I_3 = 1 + 1.666 = 2.666 \text{ A}$$

$$V_{R_{2\Omega}} = I_1 \times 2\Omega = 2.666 \times 2 = 5.333 \text{ V}$$

$$V_{R_{4\Omega}} = V_{R_{2\Omega}} + V_{AC} = 5.333 + 10$$ (V_{BA})

$$V_{R_{4\Omega}} = 15.333 \text{ V} = V_{BC}$$

$$I_4 = \frac{V_{R_{4\Omega}}}{4\Omega} = \frac{15.333 \text{ V}}{4} = 3.8333 \text{ A}$$

$$I_T = I_4 + I_1 = 2.666 + 3.8333 = 6.499 \text{ A}$$

เทียบบัญญัติไตรยางศ์

ที่ ~~$I_T = 2$ A → I_L~~

$I_T = 6.499$ A → $I_L = 1$ A

$I_T = 2$ A → $I_L = 2$

$$I_L = \frac{2 \times 1}{6.499} = 0.3077 \text{ A}$$

$$I_2 \text{ จริง} = \frac{1.666}{6.499} = 0.25634 \text{ A}$$

$$I_1 \text{ จริง} = \frac{2.666}{6.499} = 0.4102 \text{ A}$$

V = แรงดันที่ตกคร่อม $R_{2\Omega}$ และ $R_{4\Omega}$

$V_{R2\Omega} = I_1 \times 2\Omega = 0.4102 \times 2 = 0.820$ V

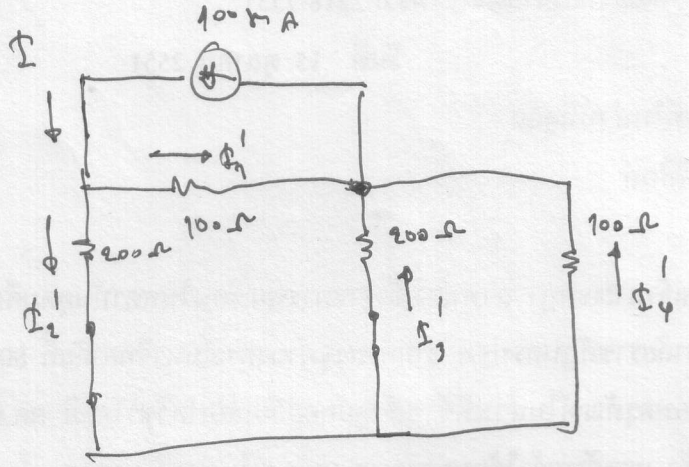
$V_{R4\Omega} = I_2 \times 4\Omega = 0.25634 \times 4\Omega = 1.025$

$V = V_{R_2} + V_{R_4} = 0.82 + 1.025$

$V = 1.845$ V ——— ✓

Thevenin $V = 3.636$ V

(8) By superposition method V.



$R_{T_1} = 200 // 100 = 66.66\ \Omega$

$R_{T_2} = 200 + R_{T_1} = 200 + 66.66 = 266.66\ \Omega$

$I'_1 = \frac{I \times R_{T_2}}{100 + R_{T_2}} = \frac{100\text{ mA} \times 266.66}{100 + 266.66}$

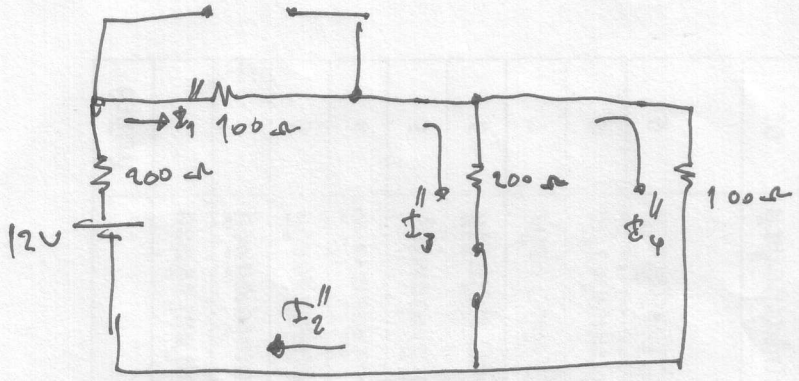
$I'_1 = 72.726$ mA

$I'_2 = I - I'_1 = 100 - 72.726 = 27.273$ mA

$I'_2 = \frac{I \times 100}{266.66 + 100} = \frac{100\text{ mA} \times 100}{366.66} = 27.273$ mA

$I'_3 = \frac{I'_2 \times 100}{200 + 100} = \frac{27.273 \times 100}{300} = 9.091$ mA

$I'_4 = I'_2 - I'_3 = 27.273 - 9.091 = 18.1819$ mA



$$I_1' = I_2''$$

$$R_{T1} = \frac{200 \times 100}{200+100} = 66.66\ \Omega$$

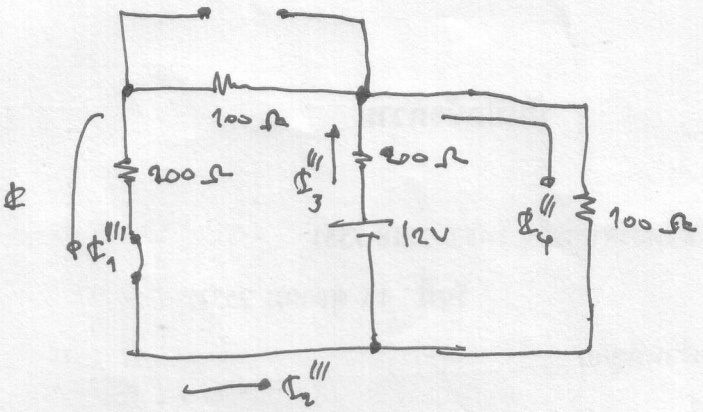
$$I_1'' = I_2'' = \frac{12}{200+100+66.66} = 0.032727 \text{ A}$$

$$I_1'' = I_2'' = 32.7278 \text{ mA}$$

$$I_3'' = \frac{I_1'' \times 100}{200+100} = \frac{32.7278 \times 100}{300} = 10.909 \text{ mA}$$

$$I_4'' = I_1'' - I_3'' = 32.7278 - 10.909 = 21.8185 \text{ mA}$$

ওঃ $I_4'' = \frac{I_1'' \times 200}{300} = 21.8185 \text{ mA}$



$V = I_4 \times 100\,\Omega$

$V = 21.8185 \times 100$

$V = 2.18\ V$

$I_1''' = I_2'''$

$R_{T1} = 200 + 100 = 300\ \Omega$

$R_{T2} = R_{T1} \,//\, 100 = \dfrac{300 \times 100}{300 + 100} = 75\ \Omega$

$R_T = 200 + R_{T2} = 275\ \Omega$

$I_3''' = \dfrac{12}{275} = 43.636\ mA$

$I_1'' = I_2'' = \dfrac{I_3''' \times 100}{300 + 100} = \dfrac{43.636 \times 100}{400}$

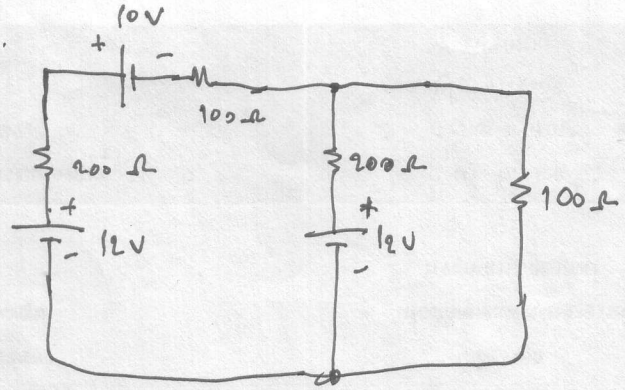
$I_1''' = I_2''' = 10.905\ mA$

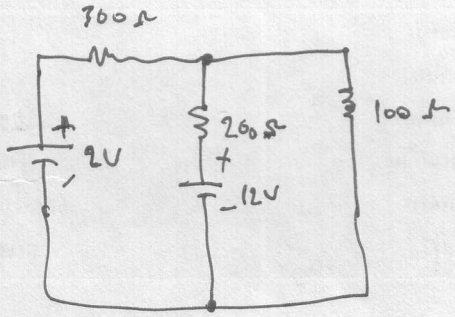
$I_4''' = I_3''' - I_1''' = 43.636 - 10.905 = 32.727\ mA$

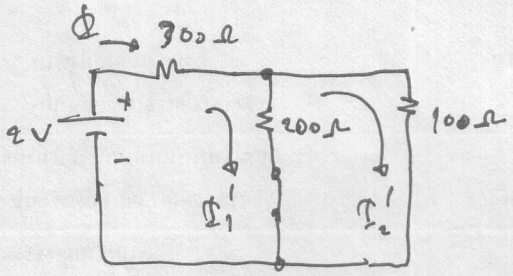
$I_4''' = \dfrac{I_3''' \times 300}{400} = \dfrac{43.636 \times 300}{400} = 32.727\ mA$

$I_4 = I_4' - I_4'' + I_4''' = 21.8185 - 32.727 + 32.727 = 21.8185\ mA$

(8)





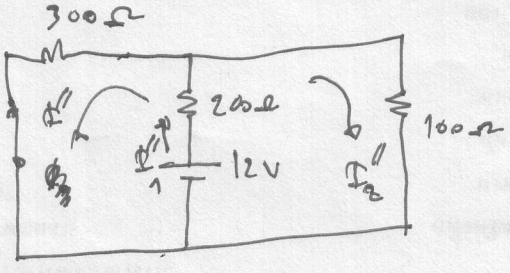


$$R_{T_1} = \frac{200 \times 100}{300} = 66.66\ \Omega$$

$$R_T = 300 + 66.66 = 366.66\ \Omega$$

$$I = \frac{2\,V}{R_T} = \frac{2}{366.66} = 5.454\ mA$$

$$I_2' = \frac{I \times 200}{200+100} = \frac{5.454 \times 200}{300} = 3.636\ mA$$



$$R_T = (300 // 100) + 200$$

$$= 75 + 200 = 275\ \Omega$$

$$I_1'' = \frac{12}{275} = 43.636\ mA$$

$$I_2'' = \frac{I_1'' \times 700}{600} = \frac{43.636 \times 300}{600}$$

$$= 32.727 \text{ mA}$$

$$I_2 = I_2' + I_2'' = 3.636 + 32.727 = 36.363 \text{ mA}$$

$$V = I_2 \times 100 = 36.363 \text{ mA} \times 100 \ \Omega$$

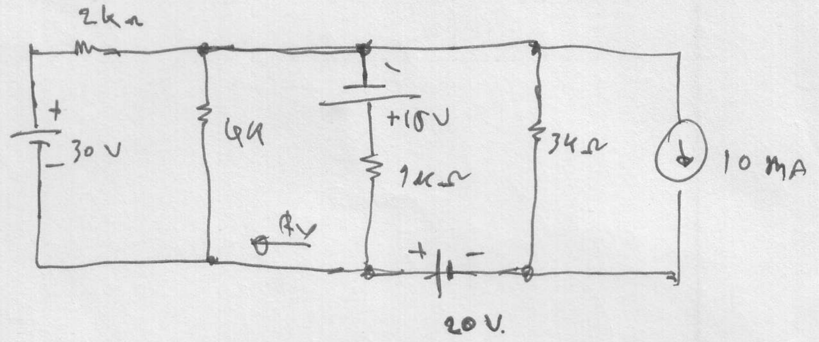
$$V = 3.636 \text{ V} \quad \text{(4)}$$

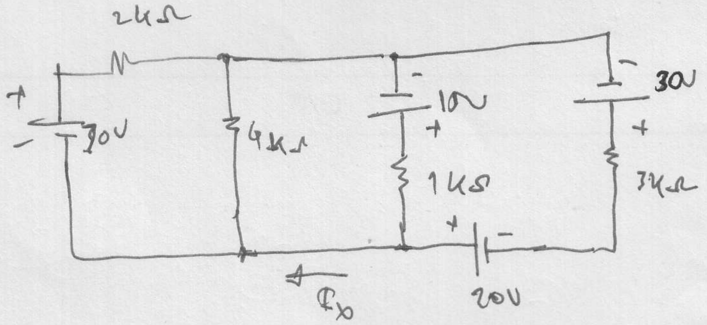
$I_x = 2.609$ mA

(5) หา I_x โดยใช้ทฤษฎีของ ซ้อนทับ

ถูกต้อง

ใช้การแปลงแหล่งจ่าย V → I
I → V.

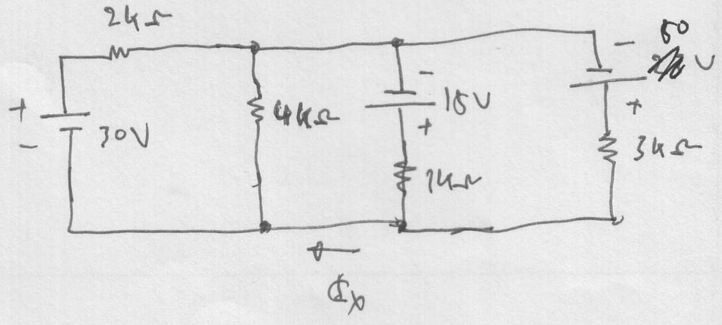


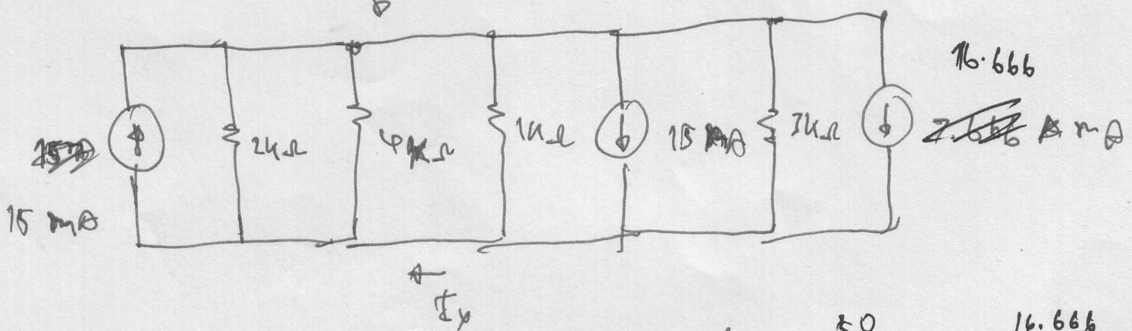


$E' = 3k\Omega \times 10mA$

$= 30V.$

$E'' = 20 + 30 = 50V.$





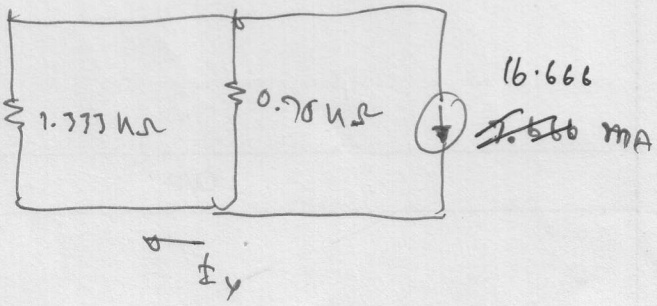
$I' = \frac{50V}{3k\Omega} = 16.666$ mA

$I_{SC} = 15 - 15 + 16.666$ mA

$I_{SC} = 16.666$ mA

$R_{T1} = 2K\Omega // 4K\Omega = 1.333\ K\Omega$

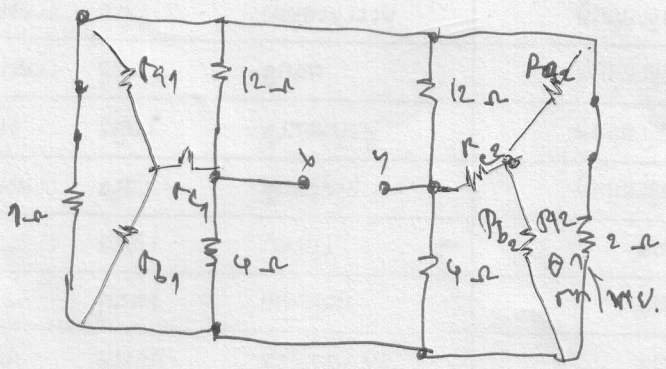
$R_{T2} = 1K\Omega // 3K\Omega = 0.75\ K\Omega$



$I_y = \frac{16.666 \times 0.75}{1.333 + 0.75} = 6$ mA

$R_{th} = 6\ \Omega$, 0W

(10)



$R_{T1} = (1+4) \,//\, 12 = \frac{5 \times 12}{5+12} = 3.529\ \Omega$

$R_{T2} = (4+2) \,//\, 12 = \frac{6 \times 12}{6+12} = 4\ \Omega$

$R_{th} = 4 + 3.529 = 7.529\ \Omega$

$$R_{a1} = \frac{1 \times 12}{1+12+4} = 0.7058\ \Omega$$

$$R_{b1} = \frac{1 \times 4}{1+12+4} = \frac{4}{17} = 0.2352\ \Omega$$

$$R_{c1} = \frac{12 \times 4}{1+12+4} = 2.823\ \Omega$$

$$R_{a2} = \frac{12 \times 2}{12+2+4} = 1.333\ \Omega$$

$$R_{b2} = \frac{2 \times 4}{18} = 0.4444\ \Omega$$

$$R_{C_2} = \frac{12 \times 4}{16} = 2.666$$

$$R_{T_1} = (R_{a_1} + R_{a_2}) // (R_{b_1} + R_{b_2})$$

$$4 = (0.7058 + 1.333) // (0.2352 + 0.4446)$$

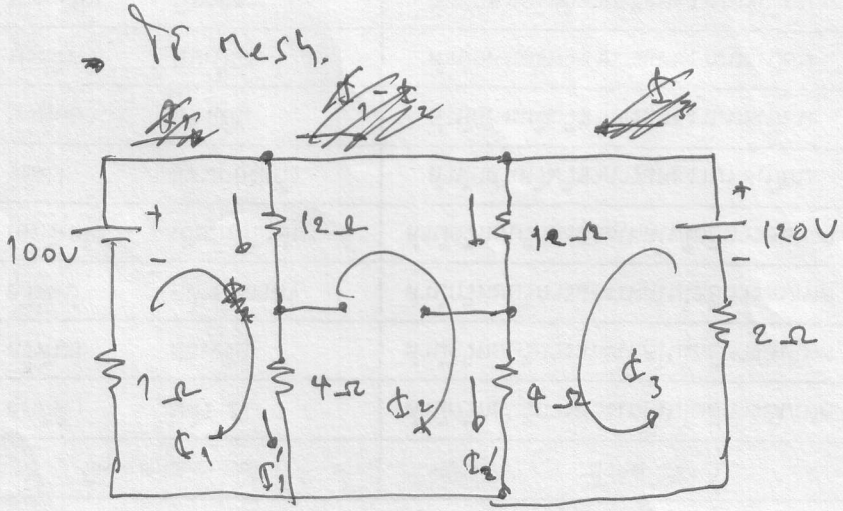
$$4 = \frac{(2.03) \times (0.6798)}{2.03 + 0.6798}$$

$$R_{T_1} = 0.508\ \Omega$$

$$R_{th} = R_{C_1} + R_{T_1} + R_{C_2} = 2.823 + 0.508 + 2.666$$

$$R_{th} = 5.999\ \Omega$$

$$R_{th} = 6\ \Omega$$



$$19I_1 - 16I_2 - 100 = 0$$

$$19I_1 - 16I_2 = 100 \quad (1)$$

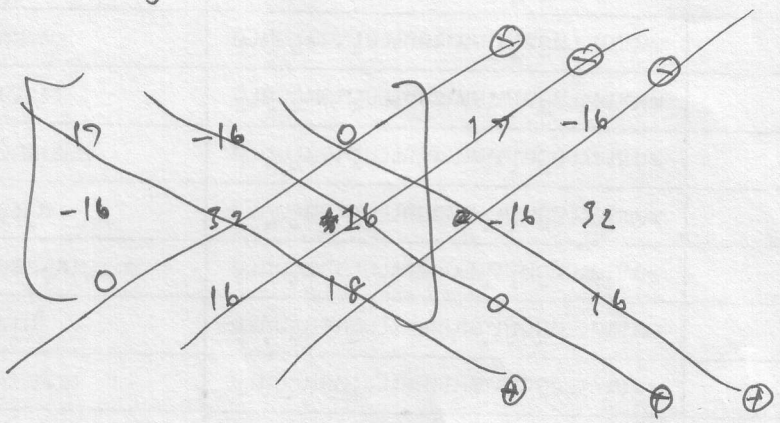
$$32I_2 - 16I_1 + 16I_3 = 0$$

$$-16I_1 + 32I_2 + 16I_3 = 0 \quad \text{——— (2)}$$

$$18I_3 + 16I_2 - 120 = 0$$

$$0 + 16I_2 + 18I_3 = 120 \quad \text{——— (3)}$$

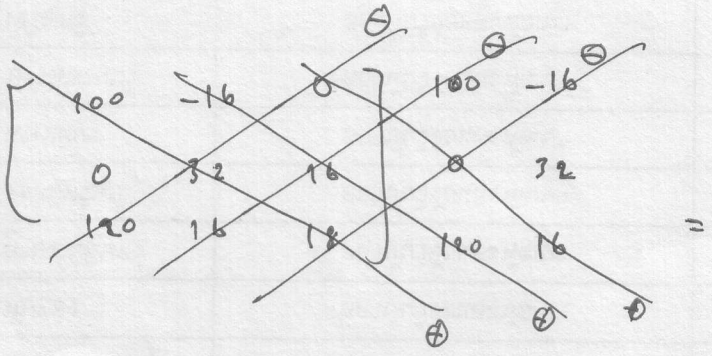
Δ =



$\Delta = 4752 + 0 + 0 - 0 - 4352 - 4608$

$\Delta = 832$

I_1 =

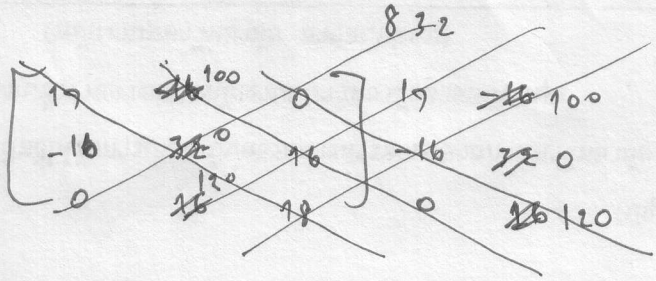


$=$

832

$$I_1 = \frac{57600 - 30720 + 0 - 0 - 28800 - 0}{832} = 1.538\ A$$

I_2 =



$$I_2 = \frac{\begin{vmatrix} 17 & 100 & 0 \\ -16 & 0 & 16 \\ 0 & 120 & 16 \end{vmatrix} \begin{matrix} 17 & 100 \\ -16 & 0 \\ 0 & 120 \end{matrix}}{832}$$

$$I_2 = \frac{0+0+0-0-32{,}640+28{,}800}{832} = -4.6153 \text{ A}$$

I_2 จริง มีค่าตรงข้ามกับ I_2 สมมุติ

$$I_3 = \frac{\begin{vmatrix} 17 & -16 & 100 \\ -16 & 32 & 0 \\ 0 & 16 & 120 \end{vmatrix} \begin{matrix} 17 & -16 \\ -16 & 32 \\ 0 & 16 \end{matrix}}{832}$$

$$I_3 = \frac{65280+0-25600-0-0-30720}{832}$$

$$I_3 = 10.769 \text{ A}$$

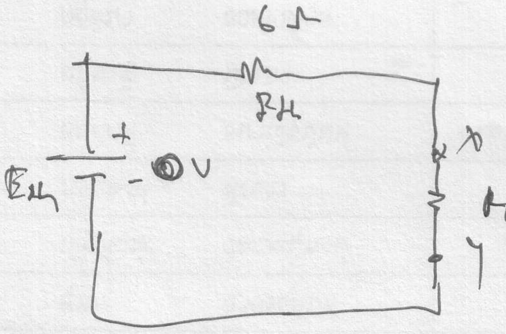
$$I_1' = I_1 + I_2 = 1.538 + 4.6153 = 6.1533 \text{ A}$$

$$I_2' = I_3 - I_2 = 10.769 - 4.6153 = 6.1537 \text{ A}$$

$$E_{th} = (I_1' \times 4\,\Omega) - (I_2' \times 4\,\Omega)$$

$$E_{th} = (6.1537 \times 4\,\Omega) - (6.1537 \times 4\,\Omega)$$

$$E_{th} = 24.614 - 24.614 = 0\ V$$

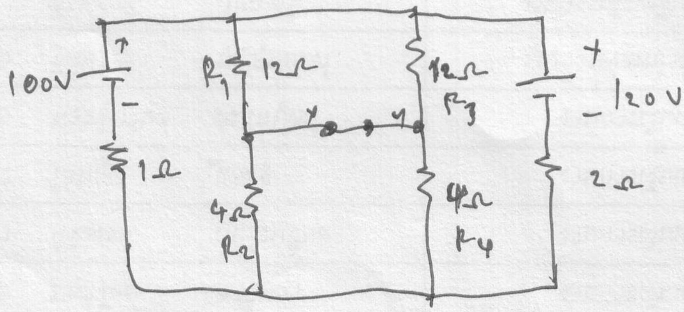


วงจรเทียบเท่าเธวินิน

$R_{L\,max} = 6\ \Omega$

$$P_L = \frac{E_{th}^2}{4R_L} = \frac{0^2}{4 \times 6} = 0\ Watt.$$

วงจรเทียบเท่านอร์ตัน หา I_{sh}.



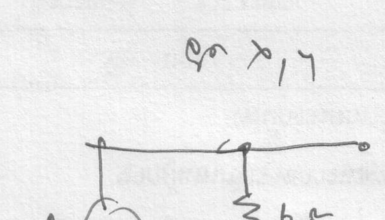
บริดจ์สมดุลย์

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \Rightarrow \frac{12}{4} = \frac{12}{4}$$

$$\frac{R_1}{R_3} = \frac{R_2}{R_4} \Rightarrow \frac{12}{12} = \frac{4}{4}$$

ดังนั้น เป็นวงจรบริดจ์สมดุลย์ จึงไม่มีกระแส I ไหลระหว่าง

จุด x, y



วงจรเทียบเท่านอร์ตัน