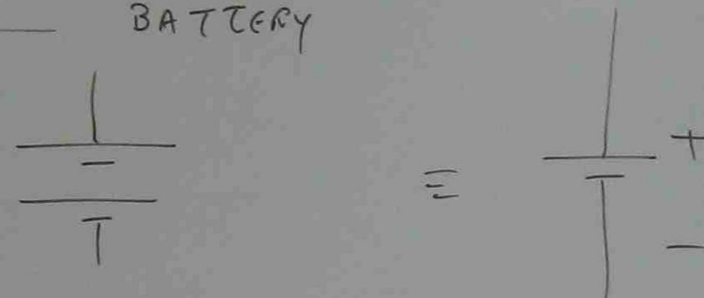
G048

CURRENT SOURCE AND VOLTAGE SOURCE

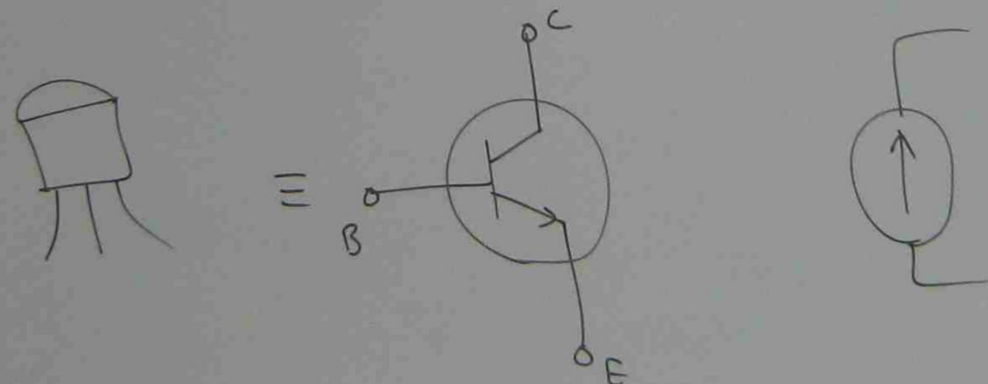
VOLTAGE SOURCE

BATTERY

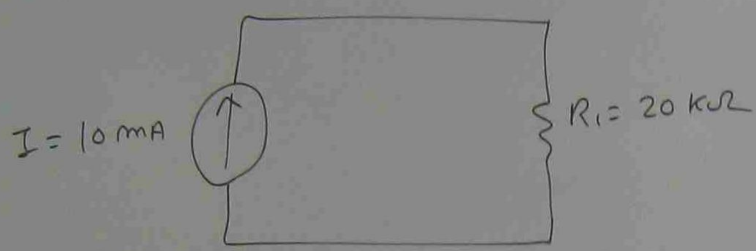


CURRENT SOURCE

TRANSISTOR



EX FIND THE SOURCE VOLTAGE V_S AND CURRENT I_1 FOR THE GIVEN CIRCUIT.

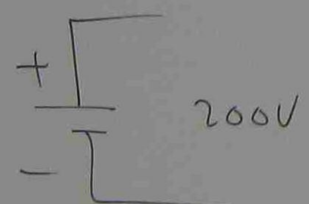


$$V_S = I R_1$$

$$= 10\,mA \times 20K$$

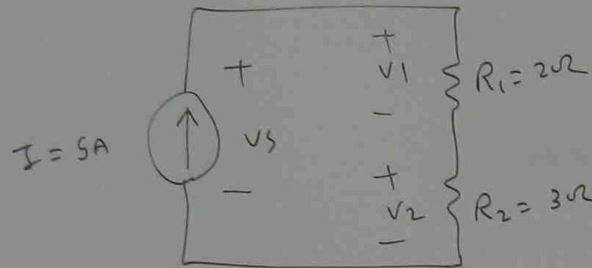
$$= 10 \times 10^{-3} \times 20 \times 10^{3}$$

$$= 200V$$



EX

CALCULATE THE VOLTAGES V_1, V_2 AND V_s FOR THE GIVEN CIRCUIT



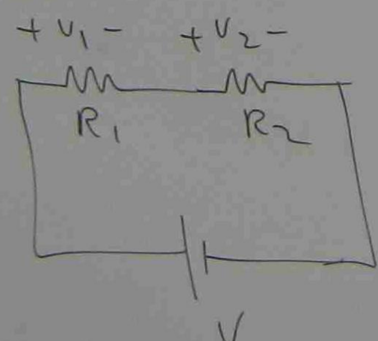
$$V = I R$$

$$V_1 = I R_1 = 5 \times 2 = 10V$$

$$V_2 = I R_2 = 5 \times 3 = 15V$$

$$V_s = V_1 + V_2 = 10 + 15 = 25V$$

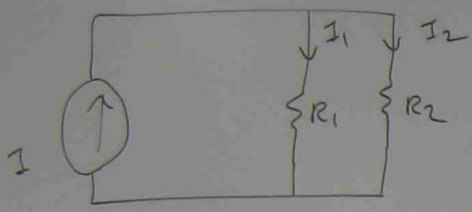
POTENTIAL DIVIDER AND CURRENT DIVIDER



$$V_1 = V \times \frac{R1}{R_1+R_2}$$

$$V_2 = V \times \frac{R2}{R_1+R_2}$$

POTENTIAL DIVIDER THEOREM

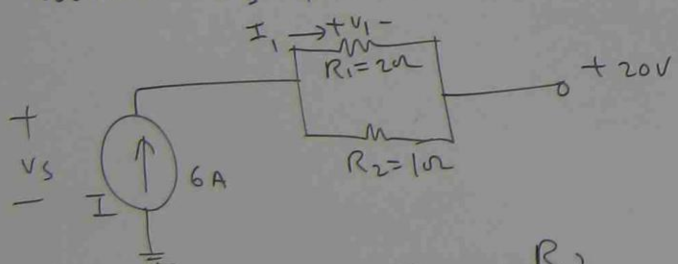


$$I_1 = I \, \frac{R_2}{R_1 + R_2}$$

$$I_2 = I \, \frac{R_1}{R_1 + R_2}$$

CURRENT DIVIDER THEOREM

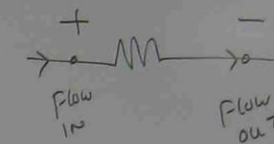
EX DETERMINE THE CURRENT I_1 AND THE VOLTAGE V_S FOR THE GIVEN NETWORK.



$$I_1 = I \times \frac{R_2}{R_1 + R_2}$$

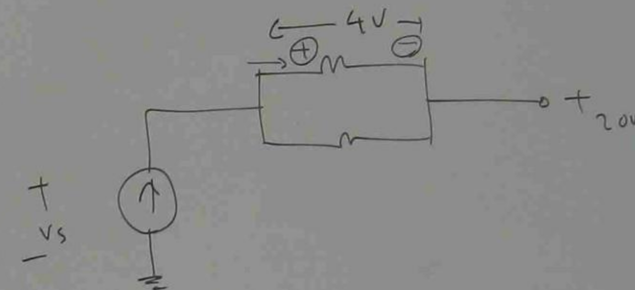
$$= 6 \times \frac{1}{2+1}$$

$$= \frac{6}{3} = 2\,A$$



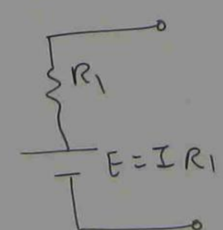
$$V_1 = I_1 R_1$$

$$= 2 \times 2 = 4\,V$$

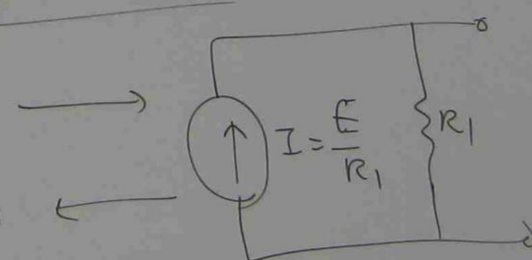


$$V_S = 4 + 20 = 24\,V$$

SOURCE CONVERSION

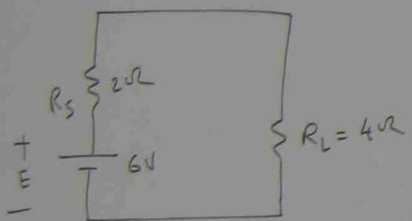


VOLTAGE SOURCE

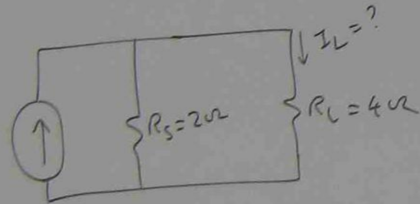


CURRENT SOURCE

EX Convert the voltage source of given figure to a current source and calculate the current through the 4 Ω load



$$\frac{E}{R_S} = \frac{6}{2} = 3A$$



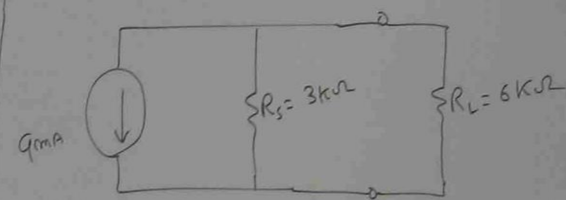
$$I_L = I_T \times \frac{R_S}{R_S + R_L}$$

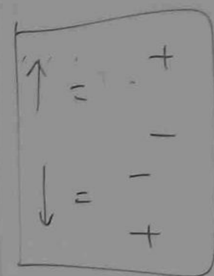
$$= 3 \times \frac{2}{2+4}$$

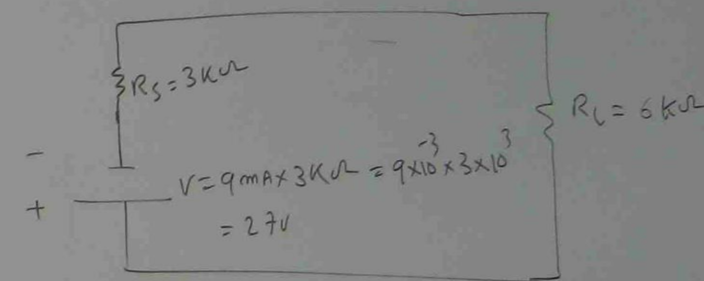
$$= \frac{12}{6}$$

$$= 2A$$

EX Convert the given current source to a voltage source and find the load current for each source.

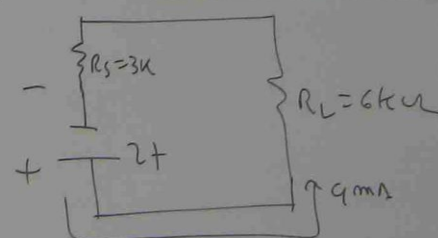






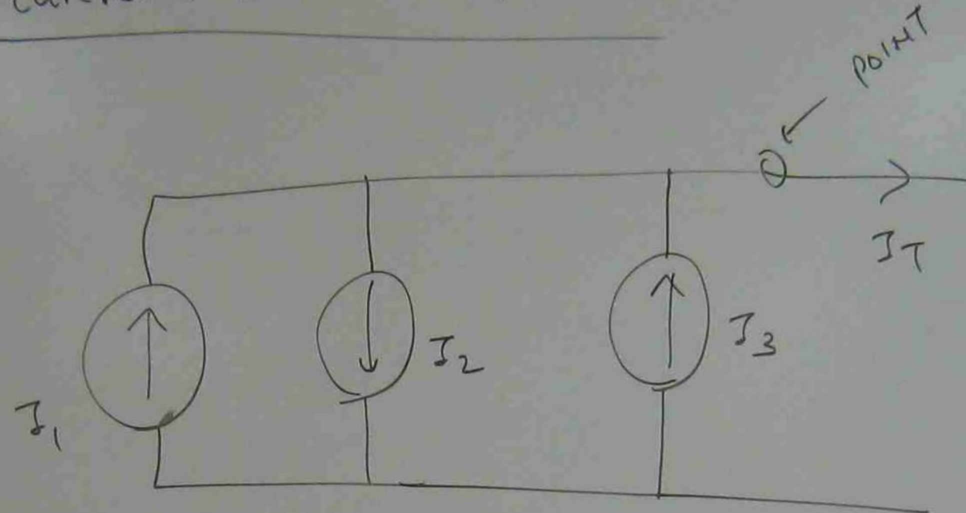
$$V = 9mA \times 3k\Omega = 9\times10^{-3} \times 3\times10^{3}$$

$$= 27V$$



Load current = 9mA

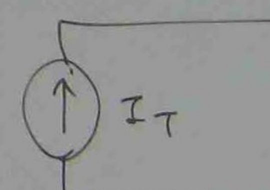
CURRENT SOURCES IN PARALLEL



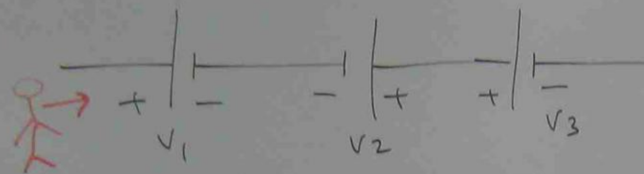
flow IN (+)

flow OUT (−)

$$I_T = +I_1 - I_2 + I_3$$



VOLTAGE SOURCES IN SERIES

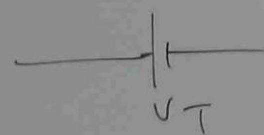


IF $\overset{+}{\longleftarrow}$ THEN $\overset{-}{\longrightarrow}$

IF $\overset{-}{\longleftarrow}$ THEN $\overset{+}{\longrightarrow}$

$$V_T = +V_1 + (-V_2) + (+V_3)$$

$$V_T = V_1 - V_2 + V_3$$



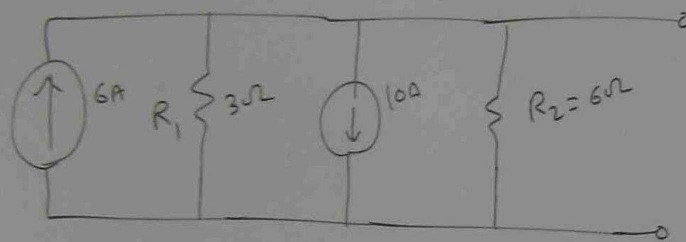
$\frac{1}{R_T} =$

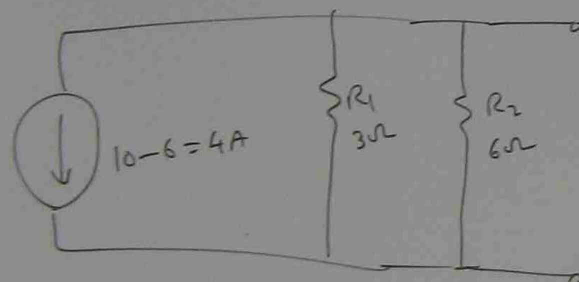
$\frac{1}{R_T}$

$V_1 + (-V_2) + (+V_3)$

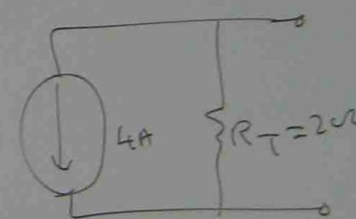
$- V_2 + V_3$

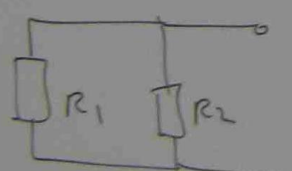
Ex REDUCE THE PARALLEL CURRENT SOURCE OF GIVEN FIGURE TO A SINGLE CURRENT SOURCE.





$\equiv$





$$R_T = \frac{3 \times 6}{3+6}$$

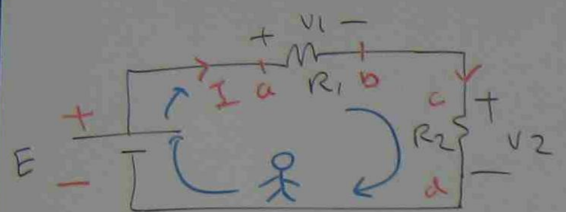
$$= \frac{18}{9} = 2\Omega$$

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_T} = \frac{R_1 + R_2}{R_1 R_2}$$

KIRCHOFF'S VOLTAGE LAW



$$(-E) + (+V_1) + (+V_2) = 0$$

$$-E + V_1 + V_2 = 0$$

$$-E + IR_1 + IR_2 = 0$$

APPLICATION OF DETERMINANT TO SOLVE THE EQUATIONS

2 UNKNOWN

$$\begin{cases} a_1 I_1 + a_2 I_2 = m_1 \\ b_1 I_1 + b_2 I_2 = m_2 \end{cases}$$

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 \\ m_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{m_1 b_2 - m_2 a_2}{a_1 b_2 - b_1 a_2}$$

$$I_2 = \frac{\begin{vmatrix} a_1 & m_1 \\ b_1 & m_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{a_1 m_2 - b_1 m_1}{a_1 b_2 - b_1 a_2}$$

3 UNKNOWN

$$a_1 I_1 + a_2 I_2 + a_3 I_3 = m_1$$

$$b_1 I_1 + b_2 I_2 + b_3 I_3 = m_2$$

$$c_1 I_1 + c_2 I_2 + c_3 I_3 = m_3$$

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 & a_3 \\ m_2 & b_2 & b_3 \\ m_3 & c_2 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_2 = \frac{\begin{vmatrix} a_1 & m_1 \\ b_1 & m_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}}$$

$$= \frac{a_1 m_2 - b_1 m_1}{a_1 b_2 - b_1 a_2}$$

3 UNKNOWN

$$a_1 I_1 + a_2 I_2 + a_3 I_3 = m_1$$

$$b_1 I_1 + b_2 I_2 + b_3 I_3 = m_2$$

$$c_1 I_1 + c_2 I_2 + c_3 I_3 = m_3$$

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 & a_3 \\ m_2 & b_2 & b_3 \\ m_3 & c_2 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_2 = \frac{\begin{vmatrix} a_1 & m_1 & a_3 \\ b_1 & m_2 & b_3 \\ c_1 & m_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_3 = \frac{\begin{vmatrix} a_1 & a_2 & m_1 \\ b_1 & b_2 & m_2 \\ c_1 & c_2 & m_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_1 = \frac{\left|\begin{array}{ccc|cc} m_1 & a_2 & a_3 & m_1 & a_2 \\ m_2 & b_2 & b_3 & m_2 & b_2 \\ m_3 & c_2 & c_3 & m_3 & c_2 \end{array}\right|}{\left|\begin{array}{ccc|cc} a_1 & a_2 & a_3 & a_1 & a_2 \\ b_1 & b_2 & b_3 & b_1 & b_2 \\ c_1 & c_2 & c_3 & c_1 & c_2 \end{array}\right|}$$

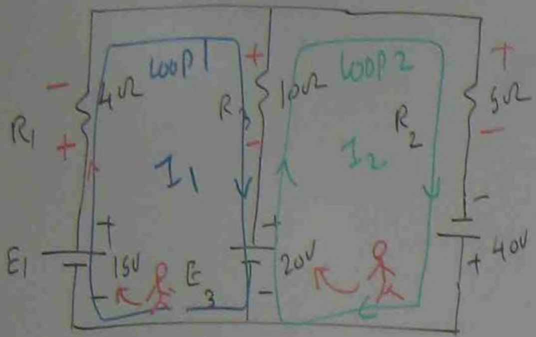
a_2

a_2

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 & a_3 & m_1 & a_2 \\ m_2 & b_2 & b_3 & m_2 & b_2 \\ m_3 & c_2 & c_3 & m_3 & c_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 & a_1 & a_2 \\ b_1 & b_2 & b_3 & b_1 & b_2 \\ c_1 & c_2 & c_3 & c_1 & c_2 \end{vmatrix}}$$

$$= \frac{(m_1 b_2 c_3 + a_2 b_3 m_3 + a_3 m_2 c_2) - (m_3 b_2 a_3 + c_2 b_3 m_1 + c_3 m_2 a_2)}{(a_1 b_2 c_3 + a_2 b_3 c_1 + a_3 b_1 c_2) - (c_1 b_2 a_3 + c_2 b_3 a_1 + c_3 b_1 a_2)}$$

Ex



FIND CURRENT I_1 AND I_2

Loop (1)

$$(-15) + (+I_1 R_1) + (I_1 - I_2)R_3 + (+20) = 0$$

$$-15 + I_1 \times 4 + (I_1 - I_2)\,10 + 20 = 0$$

$$-15 + 4I_1 + 10I_1 - 10I_2 + 20 = 0$$

$$14I_1 - 10I_2 + 5 = 0$$

$$14I_1 - 10I_2 = -5 \text{ — } (1)$$

Loop (2)

$$(-20) + (I_2 - I_1)(-R_3) + (+I_2 R_2) + (-40) = 0$$

$$-20 + (I_2 - I_1)(-10) + I_2 \times 5 - 40 = 0$$

$$-20 - 10I_2 + 10I_1 + 5I_2 - 40 = 0$$

$$10I_1 - 5I_2 - 60 = 0$$

$$10I_1 - 5I_2 = 60 \text{ — } (2)$$

$$14I_1 - 10I_2 = -5 \text{ — } (1)$$

$$a_1 I_1 + a_2 I_2 = m_1$$

$$a_1 = 14,\ a_2 = -10,\ m_1 = -5$$

$= 0$

$$10I_1 - 5I_2 = 60 \quad \text{— (2)}$$

$$b_1 I_1 + b_2 I_2 = m_2$$

$$b_1 = 10, \quad b_2 = -5, \quad m_2 = 60$$

$$I_1 = \frac{m_1 b_2 - m_2 a_2}{a_1 b_2 - b_1 a_2}$$

$$= \frac{(-5)(-5) - 60 \times (-10)}{14 \times (-5) - 10 \times (-10)}$$

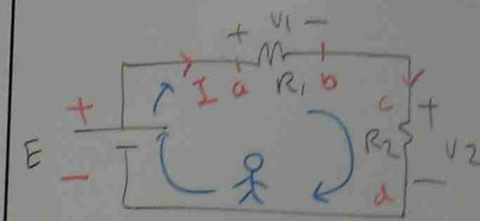
$$= \frac{25 + 600}{-70 + 100} = \frac{625}{30}$$

$$I_2 = \frac{a_1 m_2 - b_1 m_1}{a_1 b_2 - b_1 a_2}$$

$$= \frac{14 \times 60 - 10 \times (-5)}{30}$$

$$= \frac{840 + 500}{30} = \frac{1340}{30} =$$

KIRCHOFF'S VOLTAGE LAW



$$(-E) + (+V_1) + (+V_2) = 0$$

$$-E + V_1 + V_2 = 0$$

$$-E + IR_1 + IR_2 = 0$$

APPLICATION OF DETERMINANT TO SOLVE THE EQUATIONS

2 unknown

$$\begin{cases} a_1 I_1 + a_2 I_2 = m_1 \\ b_1 I_1 + b_2 I_2 = m_2 \end{cases}$$

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 \\ m_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{m_1 b_2 - m_2 a_2}{a_1 b_2 - b_1 a_2}$$

$I_2 =$

$=$

3 un

c

$$I_2 = \frac{\begin{vmatrix} a_1 & m_1 \\ b_1 & m_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}}$$

$$= \frac{a_1 m_2 - b_1 m_1}{a_1 b_2 - b_1 a_2}$$

<u>3 UNKNOWN</u>

$$a_1 I_1 + a_2 I_2 + a_3 I_3 = m_1$$

$$b_1 I_1 + b_2 I_2 + b_3 I_3 = m_2$$

$$c_1 I_1 + c_2 I_2 + c_3 I_3 = m_3$$

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 & a_3 \\ m_2 & b_2 & b_3 \\ m_3 & c_2 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_2 = \frac{\begin{vmatrix} a_1 & m_1 & a_3 \\ b_1 & m_2 & b_3 \\ c_1 & m_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_3 = \frac{\begin{vmatrix} a_1 & a_2 & m_1 \\ b_1 & b_2 & m_2 \\ c_1 & c_2 & m_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

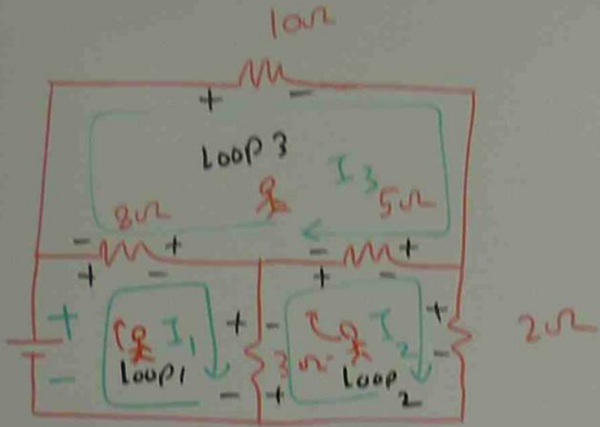
$$I_1 = \frac{\left|\begin{array}{ccc|cc} m_1 & a_2 & a_3 & m_1 & a_2 \\ m_2 & b_2 & b_3 & m_2 & b_2 \\ m_3 & c_2 & c_3 & m_3 & c_2 \end{array}\right|}{\left|\begin{array}{ccc|cc} a_1 & a_2 & a_3 & a_1 & a_2 \\ b_1 & b_2 & b_3 & b_1 & b_2 \\ c_1 & c_2 & c_3 & c_1 & c_2 \end{array}\right|}$$

$$\frac{\left[11\times10\times0+(-3)(0)(-8)+(15)(-3)(-5)\right]-\left[(-8)\times10\times15+(-5)\times0\times11+0\times(-3)(-3)\right]}{\left[11\times10\times23+(-3)(-5)\times(-8)+(-8)\times(-3)(-5)\right]-\left[(-8)(10)(-8)+(-5)(-5)\times11+23(-3)(-3)\right]}$$

$= 1.22\ \text{Amp.}$

Pb

FIND THE CURRENT THROUGH THE 10Ω RESISTOR OF THE NETWORK



Loop ①

$$-15 + [+(I_1 - I_3)] \times 8 + [+(I_1 - I_2)] \times 3 = 0$$

$$8I_1 - 8I_3 + 3I_1 - 3I_2 = 15$$

$$11I_1 - 3I_2 - 8I_3 = 15 \quad \text{— ①}$$

Loop ② $[+(I_2 - I_1)] \times 3 + [+(I_2 - I_3)] \times 5 + [+I_2] \times 2 = 0$

$$3I_2 - 3I_1 + 5I_2 - 5I_3 + 2I_2 = 0$$

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Loop

$$-3I_1 + 10I_2 - 5I_3 = 0 \quad \text{—— } (2)$$

Loop (3)

$$\left[+(I_3 - I_1)\right] \times 8 + \left[+(I_3 \times 10)\right] + \left[+(I_3 - I_2)\right] \times 5 = 0$$

$$8I_3 - 8I_1 + 10I_3 + 5I_3 - 5I_2 = 0$$

$$-8I_1 - 5I_2 + 23I_3 = 0 \quad \text{—— } (3)$$

$$a_1 I_1 + a_2 I_2 + a_3 I_3 = m_1$$

$$b_1 I_1 + b_2 I_2 + b_3 I_3 = m_2$$

$$c_1 I_1 + c_2 I_2 + c_3 I_3 = m_3$$

$$= 0$$

$$I_1 = \frac{\begin{vmatrix} m_1 & a_2 & a_3 \\ m_2 & b_2 & b_3 \\ m_3 & c_2 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_2 = \frac{\begin{vmatrix} a_1 & m_1 & a_3 \\ b_1 & m_2 & b_3 \\ c_1 & m_3 & c_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_3 = \frac{\begin{vmatrix} a_1 & a_2 & m_1 \\ b_1 & b_2 & m_2 \\ c_1 & c_2 & m_3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_1 = \frac{\begin{vmatrix} m1 & a2 & a3 \\ m2 & b2 & b3 \\ m3 & c2 & c3 \end{vmatrix}}{\begin{vmatrix} a1 & a2 & a3 \\ b1 & b2 & b3 \\ c1 & c2 & c3 \end{vmatrix}}$$

$$I_2 = \frac{\begin{vmatrix} a1 & m1 & a3 \\ b1 & m2 & b3 \\ c1 & m3 & c3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}}$$

$$I_3 = \frac{\begin{vmatrix} a_1 & a_2 & m1 \\ b_1 & b_2 & m2 \\ c1 & c_2 & m3 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c1 & c_2 & c_3 \end{vmatrix}}$$

$$I_3 = \frac{\begin{vmatrix} 11 & -3 & 15 \\ -3 & 10 & 0 \\ -8 & -5 & 0 \end{vmatrix}}{\begin{vmatrix} 11 & -3 & -8 \\ -3 & 10 & -5 \\ -8 & -5 & 23 \end{vmatrix}}$$

$$I_3 = \frac{\left|\begin{array}{ccc|cc} 11 & -3 & 15 & 11 & -3 \\ -3 & 10 & 0 & -3 & 10 \\ -8 & -5 & 0 & -8 & -5 \end{array}\right|}{\left|\begin{array}{ccc|cc} 11 & -3 & -8 & 11 & -3 \\ -3 & 10 & -5 & -3 & 10 \\ -8 & -5 & 23 & -8 & -5 \end{array}\right|} = \frac{[11 \times 1}{[11 \times 1}$$

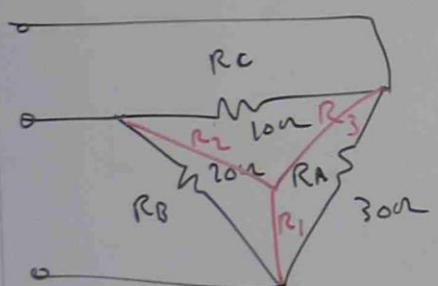
$=$

$$R_C = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

$$= \frac{60\times60 + 60\times60 + 60\times60}{60}$$

$$= 180\,\Omega$$

Ex CONVERT Δ OF GIVEN CIRCUIT TO λ



$$R_1 = \frac{R_A \times R_B}{R_A + R_B + R_C} = \frac{30\times 20}{30+20+10}$$

$$= \frac{600}{60} = 10\,\Omega$$

$$R_2 = \frac{R_B \times R_C}{R_A + R_B + R_C} = \frac{20\times 10}{60} = \frac{200}{60} = 3.33\,\Omega$$

$$R_3 = \frac{R_C \times R_A}{R_A + R_B + R_C} = \frac{10\times 30}{60} = \frac{300}{60}$$

$$= 5\,\Omega$$