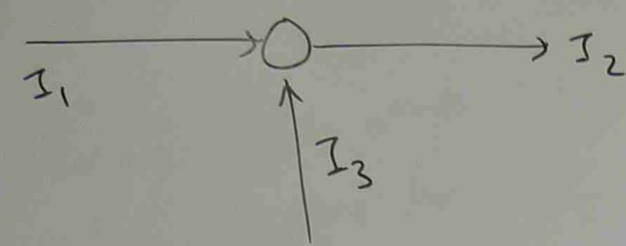
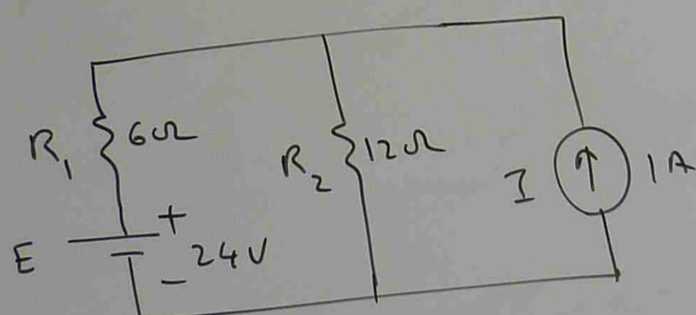
NODAL ANALYSIS



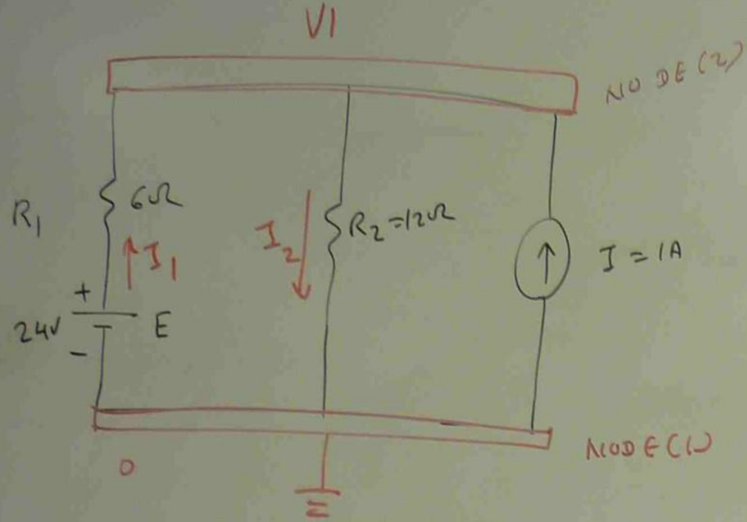
FLOW IN CURRENT = FLOW OUT CURRENT

$$I_1 + I_3 = I_2$$

Ex



CALCULATE THE CURRENT FLOWS IN TO R_2 AND DELIVERED BY 24V BATTERY USING NODAL ANALYSIS.



$I_1 = \frac{E - V_1}{R_1}$, $I_2 = \frac{V_1}{R_2}$, $I = 1\,A$

FLOW IN CURRENT = FLOW OUT CURRENT

$$I_1 + I = I_2$$

$$\frac{E - V1}{R_1} + 1 = \frac{V1}{R_2}$$

$$\frac{24 - V_1}{6} + 1 = \frac{V_1}{12}$$

$$\frac{24}{6} - \frac{V1}{6} + 1 = \frac{V1}{12}$$

$$4 - \frac{V1}{6} + 1 = \frac{V1}{12}$$

$$4 + 1 = \frac{V1}{6} + \frac{V1}{12}$$

$$5 = \frac{2V1 + V1}{12}$$

$$5 = \frac{3\,V1}{12}$$

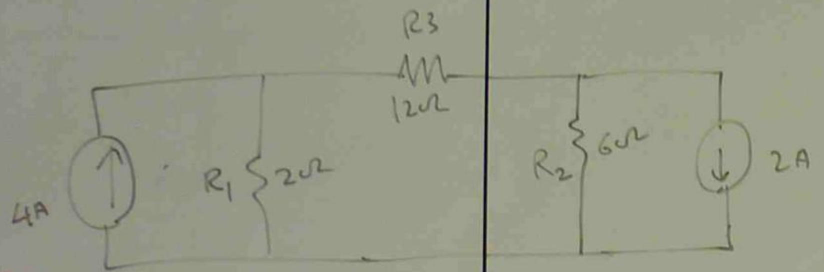
$$V_1 = \frac{5 \times 12}{3} = 20\ V$$

$$I_1 = \frac{E - V1}{R_1} = \frac{24 - 20}{6} = \frac{4}{6} = 0.667\ \text{Amp.}$$

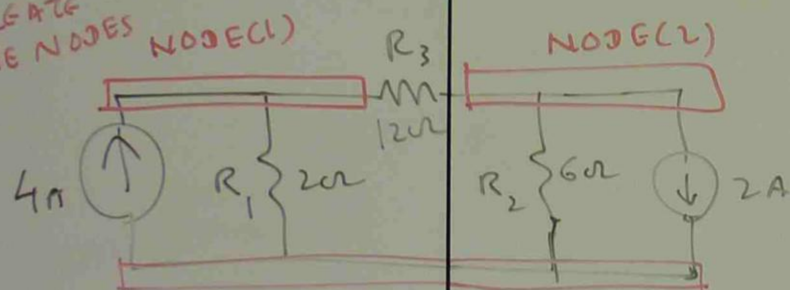
$$I_2 = \frac{V1}{R_2} = \frac{20}{12} = \frac{10}{6} = 1.66\ \text{Amp.}$$

EX

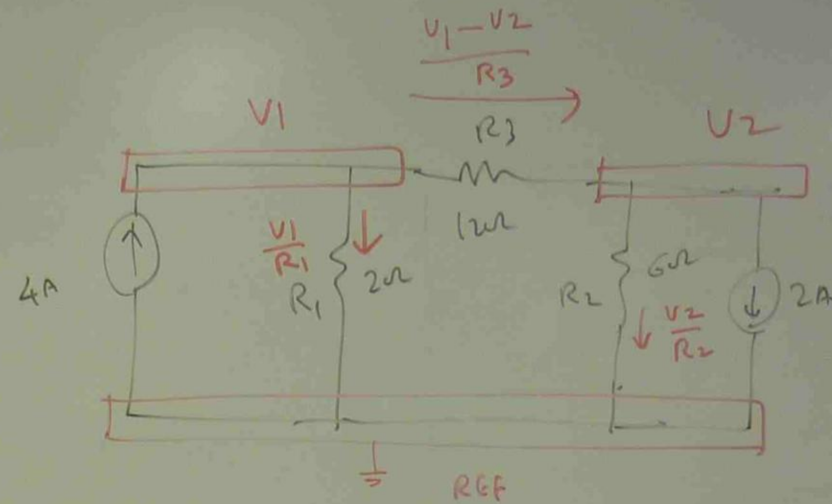
DETERMINE THE NODAL VOLTAGE FOR THE GIVEN NETWORK



(i) CREATE THE NODES



(ii) ASSIGN VOLTAGE FOR EACH NODE



V_1 NODE

FLOW IN = FLOW OUT

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

$$4 = \frac{V_1 - V_2}{12} + \frac{V_1}{2}$$

$$4 = \frac{V_1 - V_2 + 6V_1}{12}$$

$$4 = \frac{7V_1 - V_2}{12}$$

$$7V_1 - V_2 = 48 \quad (1)$$

V_2 NODE

FLOW IN = FLOW OUT

$$\frac{V_1 - V_2}{R_3} = \frac{V_2}{R_2} + 2$$

$$\frac{V_1 - V_2}{12} = \frac{V_2}{6} + 2$$

$$\frac{V_1 - V_2}{12} = \frac{V_2 + 12}{6}$$

$$V_1 - V_2 = 12 \times \frac{(V_2 + 12)}{6}$$

$$V_1 - V_2 = 2(V_2 + 12)$$

$$V_1 - V_2 = 2V_2 + 24$$

$$V_1 - 3V_2 = 24 \quad (2)$$

$$a_1 I_1 + a_2 I_2 = m_1$$

$$b_1 I_1 + b_2 I_2 = m_2$$

$$V_1 = \frac{\begin{vmatrix} m_1 & a_2 \\ m_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{\begin{vmatrix} 48 & -1 \\ 24 & -3 \end{vmatrix}}{\begin{vmatrix} 7 & -1 \\ 1 & -3 \end{vmatrix}}$$

$$V_2 = \frac{\begin{vmatrix} a_1 & m_1 \\ b_1 & m_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{\begin{vmatrix} 7 & 48 \\ 1 & 24 \end{vmatrix}}{\begin{vmatrix} 7 & -1 \\ 1 & -3 \end{vmatrix}}$$

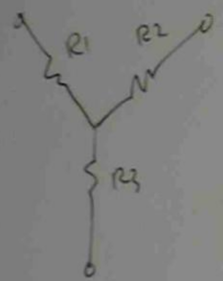
$$a_1 I_1 + a_2 I_2 = m_1$$

$$b_1 I_1 + b_2 I_2 = m_2$$

$$V_1 = \frac{\begin{vmatrix} m_1 & a_2 \\ m_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{\begin{vmatrix} 48 & -1 \\ 24 & -3 \end{vmatrix}}{\begin{vmatrix} 7 & -1 \\ 1 & -3 \end{vmatrix}} = \frac{48(-3) - (24)(-1)}{7(-3) - (1)(-1)} = \frac{-144 + 24}{-21 + 1} = \frac{-120}{-20} = 6\ V$$

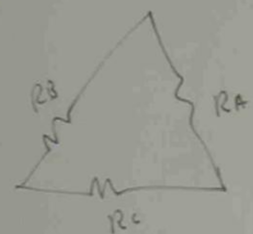
$$V_2 = \frac{\begin{vmatrix} a_1 & m_1 \\ b_1 & m_2 \end{vmatrix}}{\begin{vmatrix} a_1 & a_2 \\ b_1 & b_2 \end{vmatrix}} = \frac{\begin{vmatrix} 7 & 48 \\ 1 & 24 \end{vmatrix}}{\begin{vmatrix} 7 & -1 \\ 1 & -3 \end{vmatrix}} = \frac{7 \times 24 - 48 \times 1}{-20} = \frac{+120}{-20} = -6\ V$$

Δ AND Δ ⅄ CONVERSION



STAR / WYE (Y)

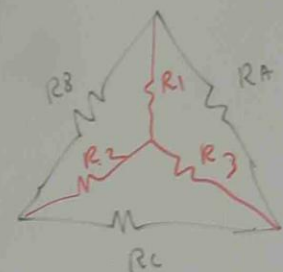
CONNECTION



DELTA / MESH (Δ)

CONNECTION

DELTA TO STAR CONVERSION

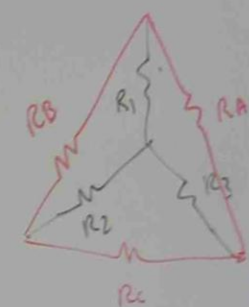


$$R_1 = \frac{R_A \times R_B}{R_A + R_B + R_C}$$

$$R_2 = \frac{R_B \times R_C}{R_A + R_B + R_C}$$

$$R_3 = \frac{R_C \times R_A}{R_A + R_B + R_C}$$

STAR TO DELTA CONVERSION



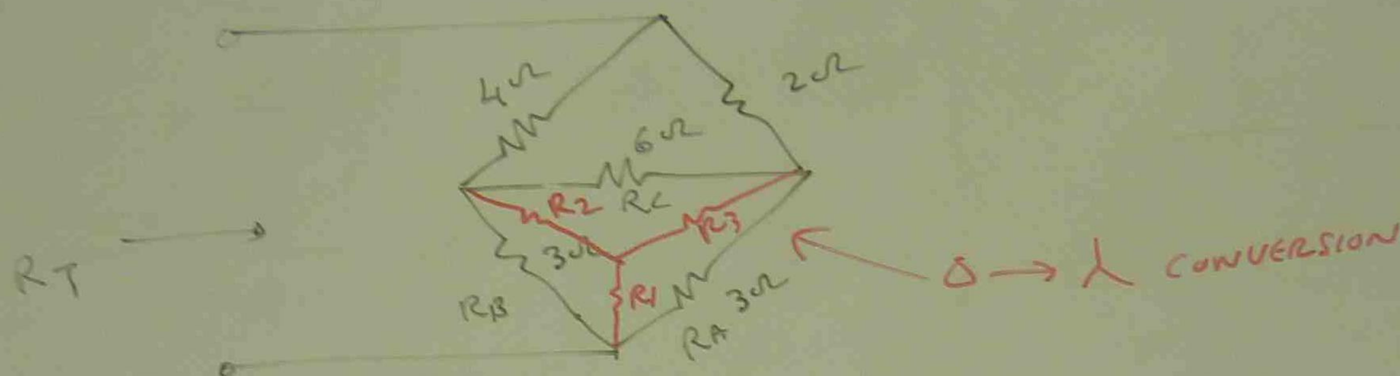
$$R_A = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

$$R_B = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

$$R_C = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

Ex

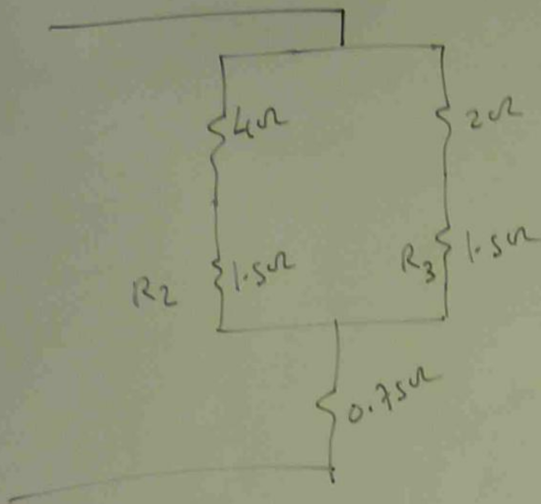
FIND TOTAL RESISTANCE OF THE GIVEN NETWORK.

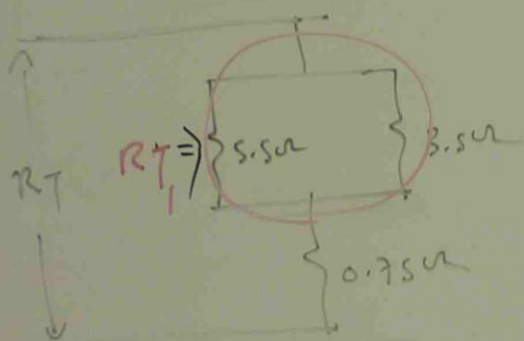


$$R_1 = \frac{R_A \times R_B}{R_A + R_B + R_C} = \frac{3 \times 3}{3+3+6} = \frac{9}{12} = 0.75\,\Omega$$

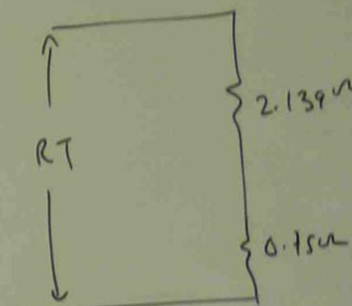
$$R_2 = \frac{R_B \times R_C}{R_A + R_B + R_C} = \frac{3 \times 6}{3+3+6} = \frac{18}{12} = 1.5\,\Omega$$

$$R_3 = \frac{R_C \times R_A}{R_A + R_B + R_C} = \frac{6 \times 3}{3+3+6} = \frac{18}{12} = 1.5\,\Omega$$

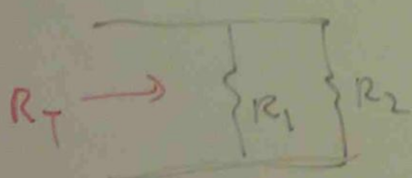




$\Rightarrow$ $$R_{T_1} = \frac{5.5 \times 3.5}{5.5 + 3.5} = 2.139\,\Omega$$



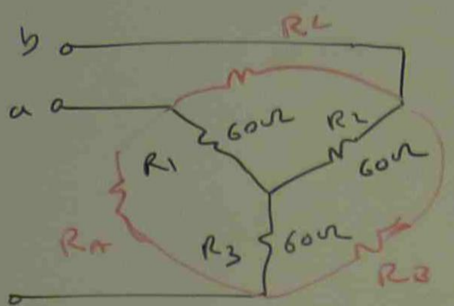
$$R_T = 2.139 + 0.75$$
$$= 2.889\,\Omega$$



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

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

EX CONVERT THE Y OF GIVEN CIRCUIT TO Δ



$$R_A = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$

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

$$= 180\Omega$$

$$R_B = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$

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

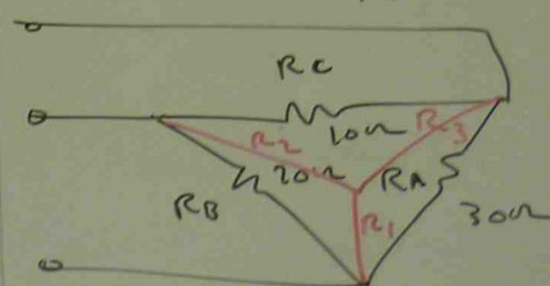
$$= 180\Omega$$

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

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

$$= 180\Omega$$

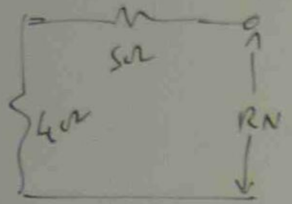
EX CONVERT Δ OF GIVEN CIRCUIT TO λ



$$R_1 = \frac{R_A \times R_B}{R_A + R_B + R_C} = \frac{30\times20}{30+20+10}$$

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

III FIND THE EQUIVALENT RESISTANCE ACROSS TERMINAL

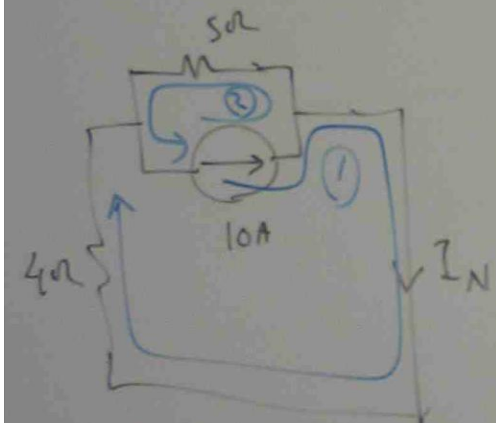


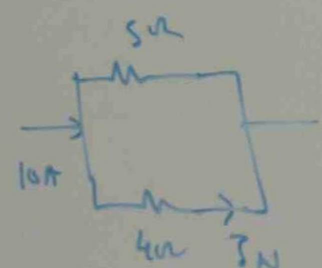
$R_N = 4 + 5 = 9\Omega$

IV FIND NORTON CURRENT

RECONNECT THE SOURCE

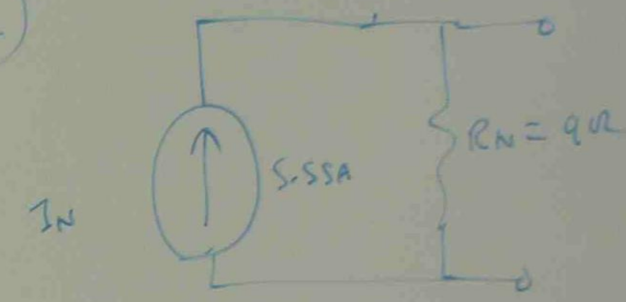
SHORT CIRCUIT THE TERMINAL





$$I_N = 10 \times \frac{5}{5+4} = \frac{50}{9} = 5.55\,A$$

V



NORTON EQUIVALENT CIRCUIT.