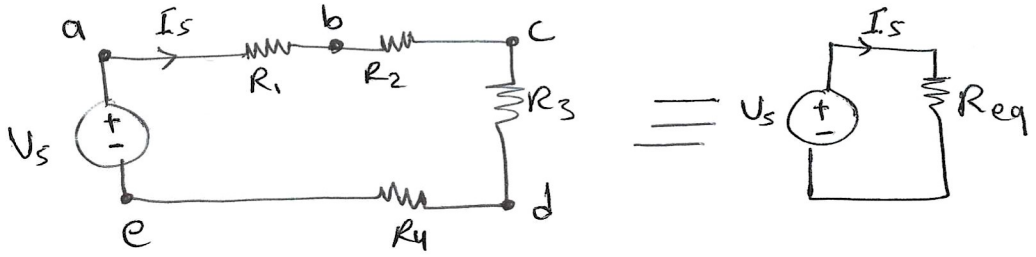
Chapter 3 :- Simple Resistive Circuits

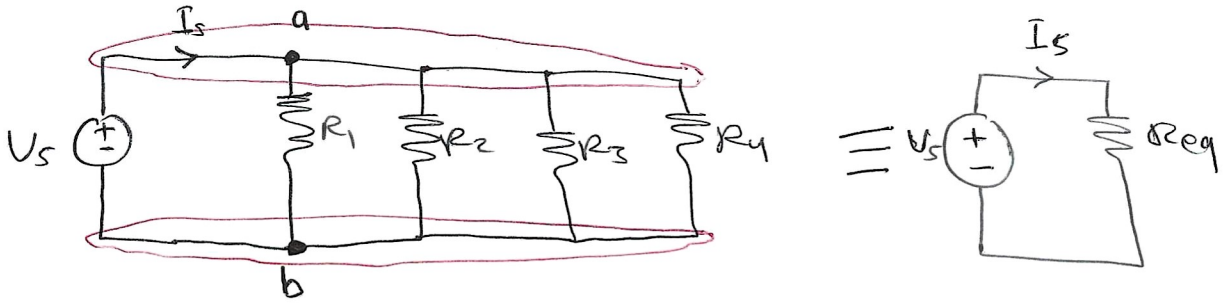
3.1 Resistors in series :-



$$R_{eq} = R_1 + R_2 + R_3 + R_4$$

$$= \sum_{i=1}^{n} R_i$$

3.2 Resistors in parallel :-

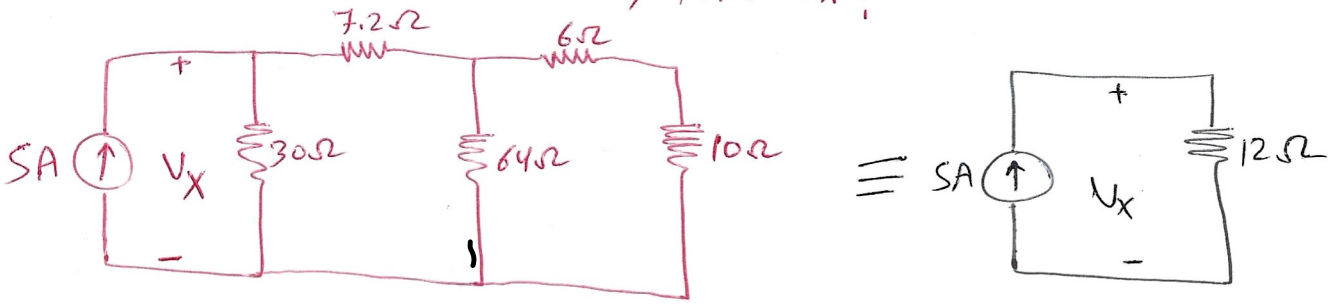


$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

Two resistors in parallel

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}, \quad 0.5\min(R_1, R_2) \leq R_{eq} < \min(R_1, R_2)$$

Example :- For the circuit shown, find v_x ?



$6 + 10 = 16$

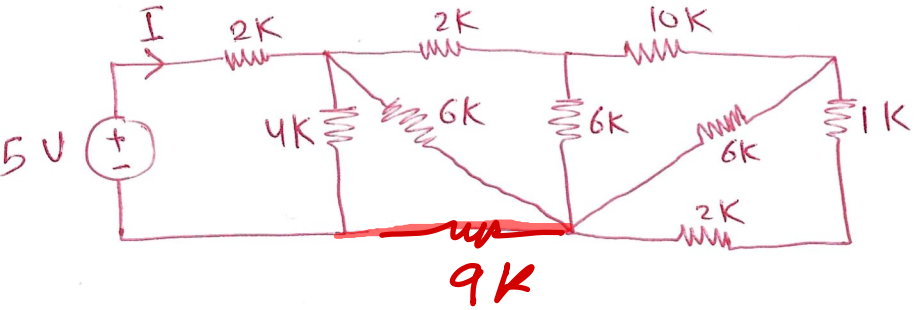
$16 // 64 = 12.8\ \Omega$

$12.8 + 7.2 = 20$

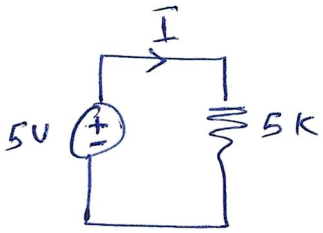
$20\Omega // 30\Omega = 12\Omega$

$V_x = (5)(12) = 60\ V$

Example:- For the following circuit, find I?



$\equiv$



$1+2 = 3K$

$3K // 6K = 2K$

$2K + 10K = 12K$

$12 // 6 = 4K$

$4K + 2K = 6K$

$6K // 6K = 3K$

$3K + 9K = 12K$

$12K // 4K = 3$

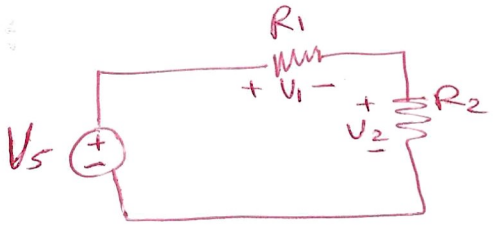
$3K + 2K = 5K\Omega$

$I = \frac{5V}{5K\Omega}$

$= 1mA$

3.3 The Voltage-devider and Current-devider Circuits:-

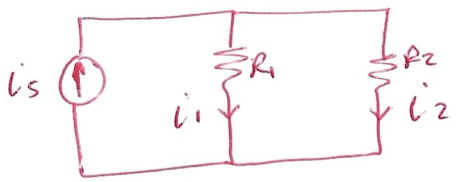
* Voltage devider:-



$$V_1 = \frac{V_s R_1}{R_1 + R_2}$$

$$V_2 = \frac{V_s R_2}{R_1 + R_2}$$

* Current devider:-

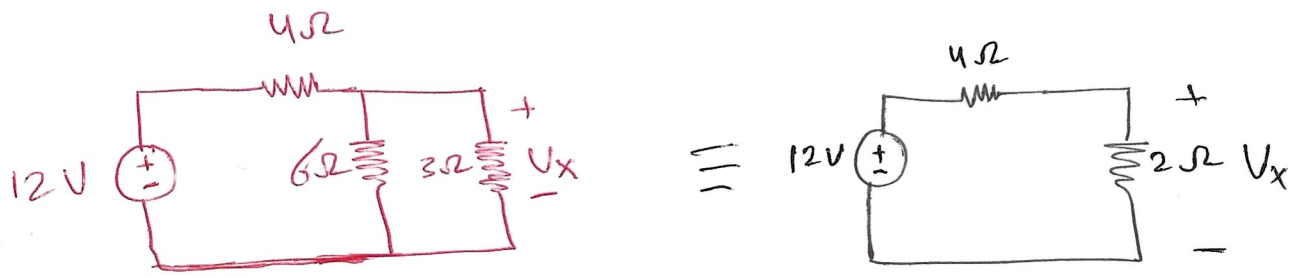


$$i_1 = \frac{i_s R_2}{R_1 + R_2}$$

$$i_2 = \frac{i_s R_1}{R_1 + R_2}$$

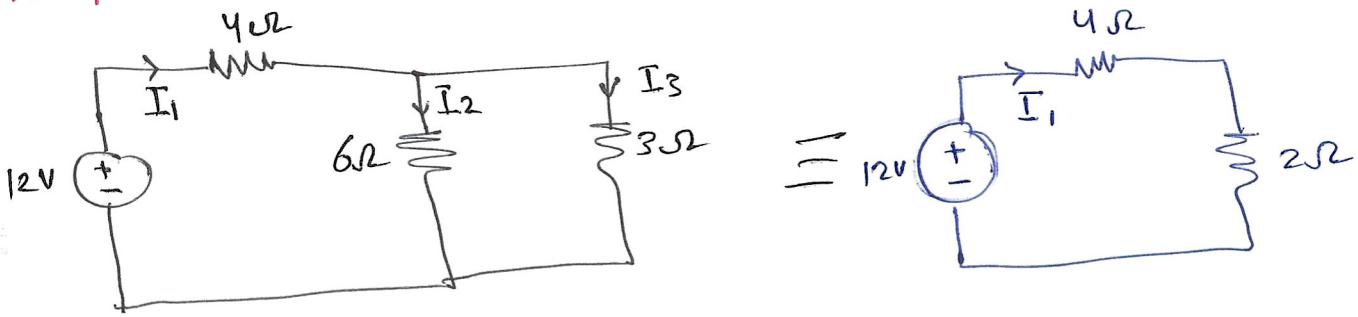
$$i_j = \frac{R_{eq}\, i_s}{R_j}$$

Example:- For the circuit shown, find V_x?



$$V_x = 12\left(\frac{2}{4+2}\right) = 4V$$

Example:- For the circuit shown, find I_3?



$$I_1 = \frac{12}{4+2} = 2A$$

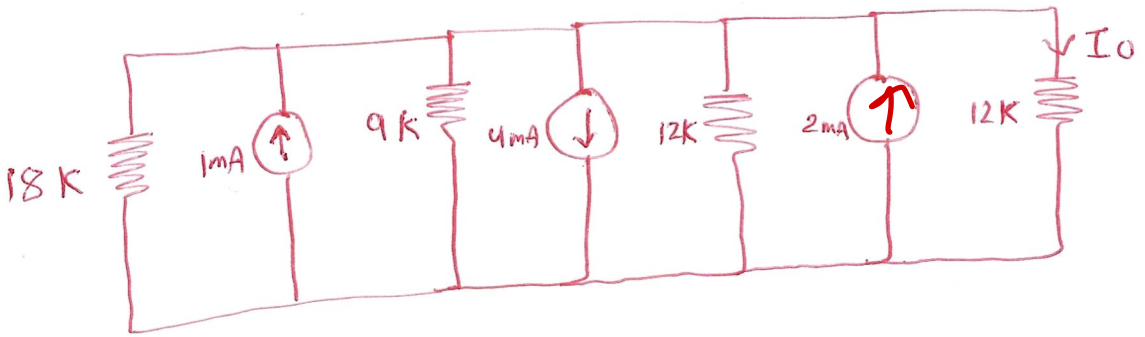
$$I_3 = 2\left(\frac{6}{6+3}\right) = 1.33A$$

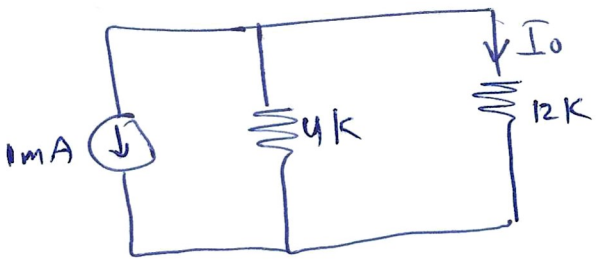
Example:- For the circuit shown, find V_o?

$$I_o = \frac{0.9mA\ (60K)}{60K + (40K + 80K)} = 0.3mA$$

$$V_o = 80K(0.3mA) = 24V$$

Example- For the circuit shown, find I_o ?

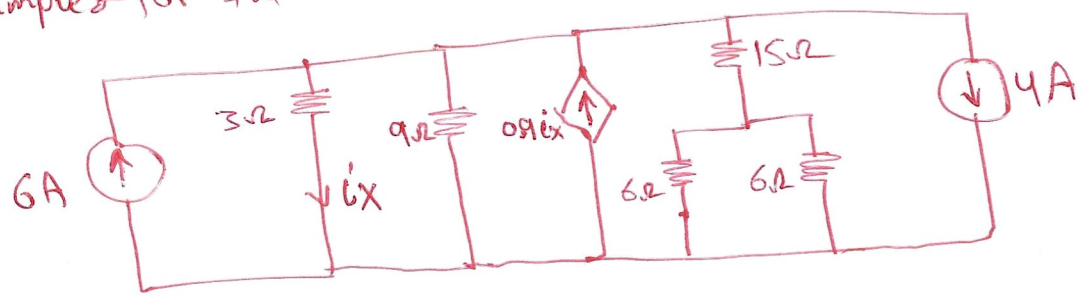


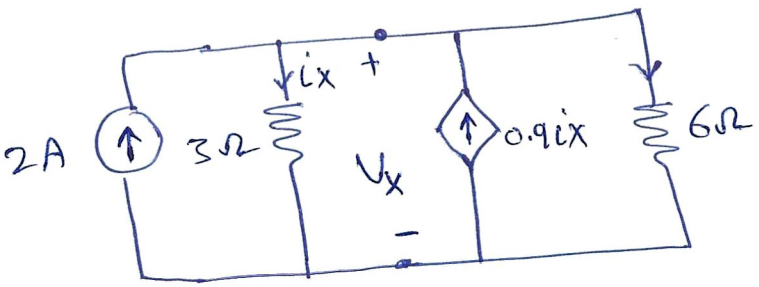


$18K \,//\, 12K \,//\, 9K = 4K$

$$I_o = \frac{1mA\,(4K)}{4K + 12K} = 0.25\,mA$$

Example- for the circuit shown, find the power supplied by 0.9ix source



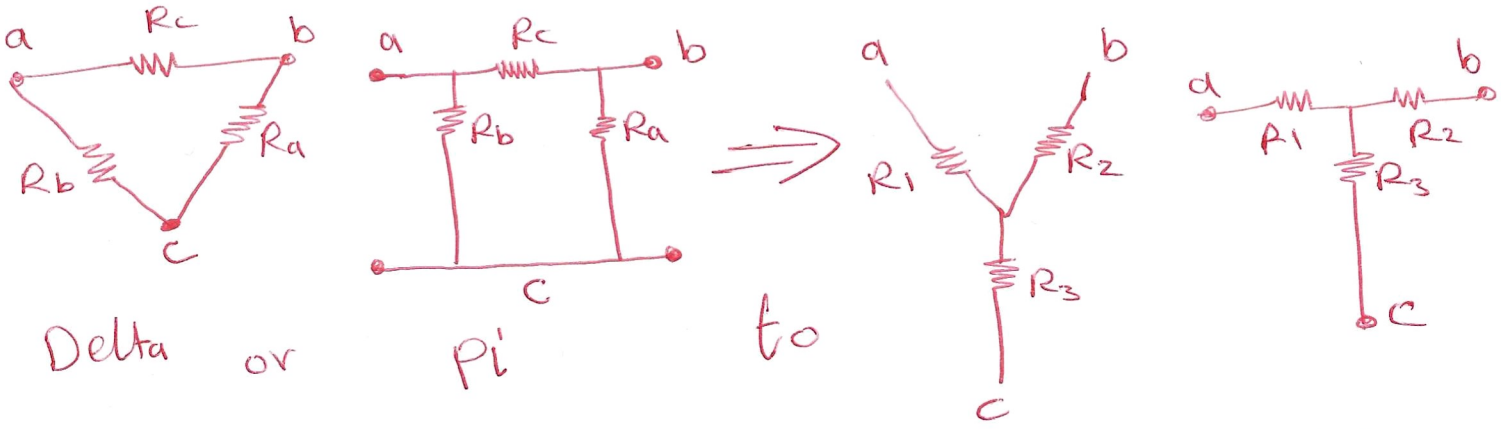


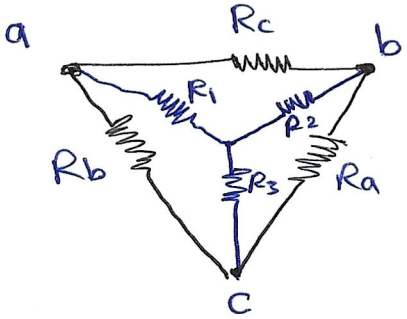
$$2 + 0.9i_x = i_x + \frac{V_x}{6} \quad , \quad i_x = \frac{V_x}{3}$$

$$\therefore V_x = 10V \quad , \quad i_x = \frac{10}{3}A$$

$$p_{0.9ix} = -(0.9i_x)V_x = -30\,W \text{ supplying}$$

3.7 Delta-to-Wye (pi-to-Tee) Transformation





$\Delta - Y$

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

$Y - \Delta$

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

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

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

For the balanced case where

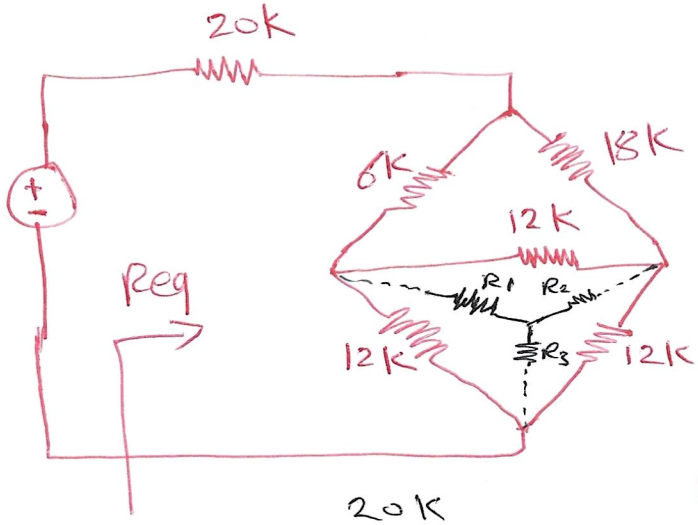
$R_a = R_b = R_c = R_\Delta$

$R_1 = R_2 = R_3 = R_y$

$R_\Delta = 3 R_y$

$R_y = \frac{1}{3} R_\Delta$

Example:- For the circuit shown, find Req

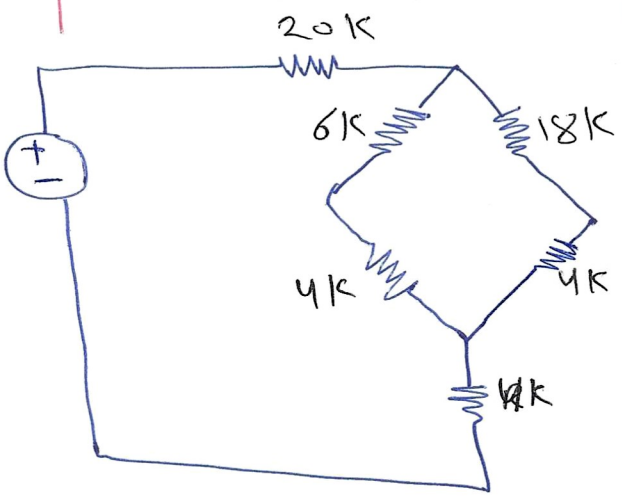


$R_a = R_b = R_c = R_\Delta$

$R_\Delta = 12K$

$R_y = \frac{1}{3} R_\Delta = \frac{12K}{3} = 4K$

$R_1 = R_2 = R_3 = R_y$

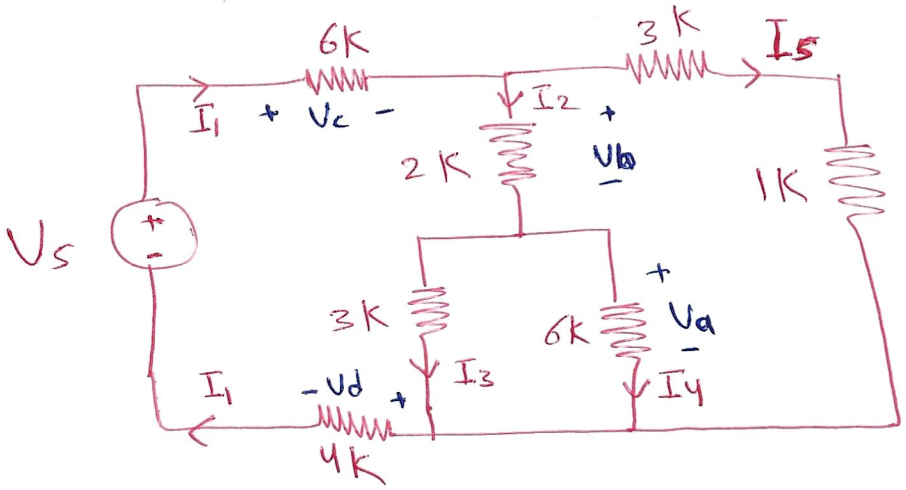


$$Req = \left[20K + (18K + 4K) // (6K + 4K) + 4K \right]$$

$$= 20 + 22 // 10 + 4$$

$$= 30.88 K\Omega$$

Design :- For the circuit shown, given $I_4 = 0.5mA$, find V_s



$$V_a = (6K)(0.5mA) = 3V$$

$$I_3 = \frac{V_a}{3K} = \frac{3V}{3K} = 1mA$$

$$I_2 = I_3 + I_4 = 1 + 0.5 = 1.5\ mA$$

$$V_b = (2K)(1.5\ mA) = 3V$$

$$I_5 = \frac{V_a + V_b}{(3+1)\ K\Omega} = \frac{6V}{4K} = 1.5mA$$

$$I_1 = I_2 + I_5 = 3mA$$

$$V_c = (6K)(3mA) = 18V$$

$$V_d = (4K)(3mA) = 12V$$

$$-V_s + V_c + V_b + V_a + V_d = 0$$

$$V_s = V_c + V_b + V_a + V_d = 36V$$