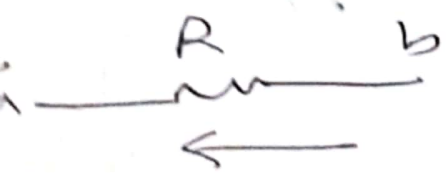
(3) Methods of Analysis

i) Nodal Analysis, — current eq.
ii) Mesh Analysis — voltage eq.

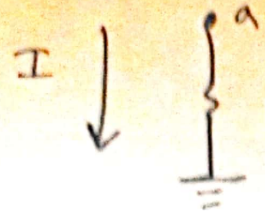
$$I = \frac{V_a - V_b}{R}$$

current



$$I = \frac{V_b - V_a}{R}$$

$$V_{ab} = V_a - V_b$$

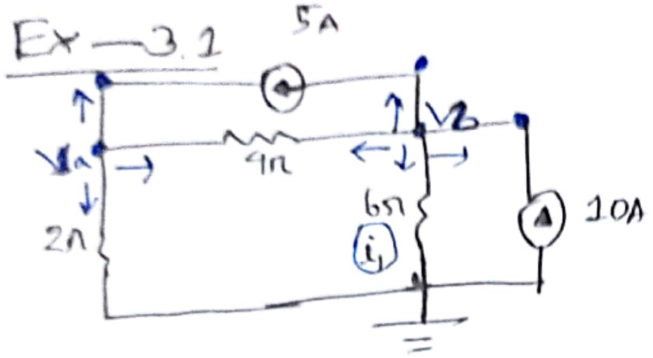


$I = \frac{V_a - V_g}{R}$ Voltage / Resistance

$= \frac{V_a - 0}{R}$

$= \frac{V_a}{R}$

Ex—3.1



$i_1 = \frac{V_b - 0}{6} = \frac{20}{6} = 3.33A$

$i_2 = \frac{V_a - V_b}{4}$ Direction অনুযায়ী

Calculate the Node Voltages

Ans: ২টি Node এর equation [Ground বাদে]

Node A : ↓ এর দিকে $\frac{V_a - 0}{R} = \frac{V_a}{2}$

$\frac{V_a}{2\Omega} + \frac{V_a - V_b}{4\Omega} - 5 = 0$ [↑ দিকের জন্য Direction ←↓→]

$\Rightarrow \left(\frac{1}{2} + \frac{1}{4}\right) V_a - \frac{1}{4} V_b = 5 \quad -(i)$

Node B: $\frac{V_b}{6} + \frac{V_b - V_a}{4} + 5 - 10$

$\Rightarrow -\frac{2}{4} V_a + \left(\frac{1}{6} + \frac{2}{4}\right) V_b = 5 \quad -(ii)$

সমাধান করলে পাই, $V_a = 13.33V$

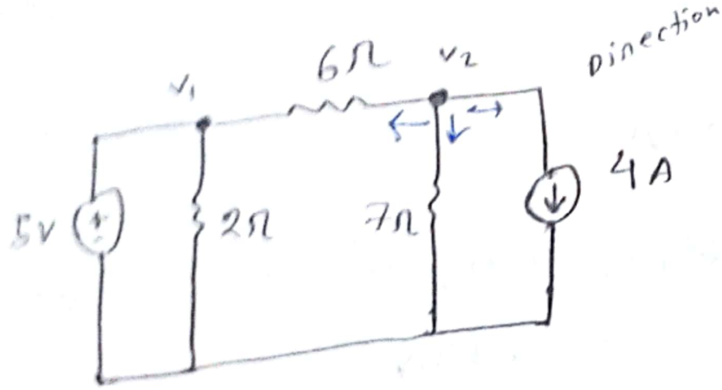
$V_b = 20V$

$a_1 x + b_1 y = c_1$

Power dissipation in 6Ω

$P_{6\Omega} = i_1^2 \times 6 = 3.33^2 \times 6$

Practice-1



$V_1 = 5V$, (∓) ঋণাত্মক হলে $V_1 = -5V$

কোন নোডে voltage source থাকলে equation লিখতে হবেনা।

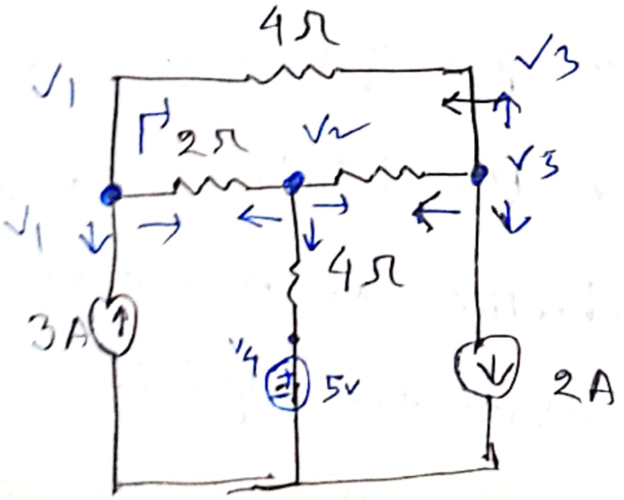
Node-2

$$\frac{V_2 - V_a(5V)}{6} + \frac{V_2}{7} + 4 = 0$$

$$\Rightarrow \left(\frac{2}{6} + \frac{2}{7}\right) V_2 = -4 + \frac{5}{6}$$

$$\therefore V_2 = -3.16V$$

Practice-2



Ground - Reference Node

V - Non " "

V_2 —(±)— V_3 super node ×

Find the node voltages

Ans:

Node-1

$$-3 + \frac{v_1 - v_2}{2} + \frac{v_1 - v_3}{4} = 0$$

$(\downarrow)$ $(\rightarrow)$ $(\leftarrow)$

$$\Rightarrow \left(\frac{1}{2} + \frac{1}{4}\right) v_1 - \frac{1}{2} v_2 - \frac{1}{4} v_3 = 3 \quad \text{---(i)}$$

Node-2

$$\frac{v_2 - v_1}{2} + \frac{v_2}{4} + \frac{v_2 - v_3}{8} = 0$$

$$\Rightarrow -\frac{1}{2} v_1 + \left(\frac{1}{2} + \frac{1}{4} + \frac{1}{8}\right) v_2 - \frac{1}{8} v_3 = 0 \quad \text{---(ii)}$$

Node-3

$$\frac{v_3 - v_2}{8} + 2 + \frac{v_3 - v_1}{4} = 0$$

$$\Rightarrow -\frac{1}{4} v_1 - \frac{1}{8} v_2 + \left(\frac{1}{4} + \frac{1}{8}\right) v_3 = -2 \quad \text{---(iii)}$$

$v_1 = 6.85V$, $v_2 = 4V$, $v_3 = 0.57V$

$$i_0 = \frac{6.85 - 0.57}{4} = 1.57A$$

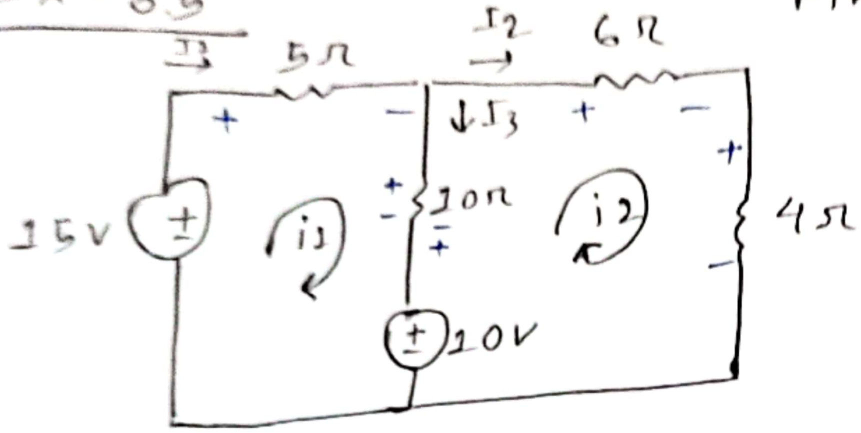
$$i_1 = \frac{v_2}{4} = 1A$$

$$P_{4\Omega} = 1 \times 4 = 4W$$

Mesh Analysis:

- Apply KVL – Voltage Equation
- no. of mesh – no. of equation

Ex-35 Find I_1, I_2, I_3



Mesh নেওয়ার সময়, overlapping ছাড়া কোনো খেয়াল প্রয়োজনের ক্ষেত্রে clockwise/anticlockwise

Mesh 1: (→ overlapping এর জন্য)

$$-15 + 5i_1 + 10(i_1 - i_2) + 10 = 0$$

$$\Rightarrow 3i_1 - 2i_2 = 1 \quad \text{——— (i)}$$

Mesh 2:

$$6i_2 + 4i_2 + 10(i_2 - i_1) - 10 = 0$$

$$\Rightarrow i_1 = 2i_2 - 1 \quad \text{——— (ii)}$$

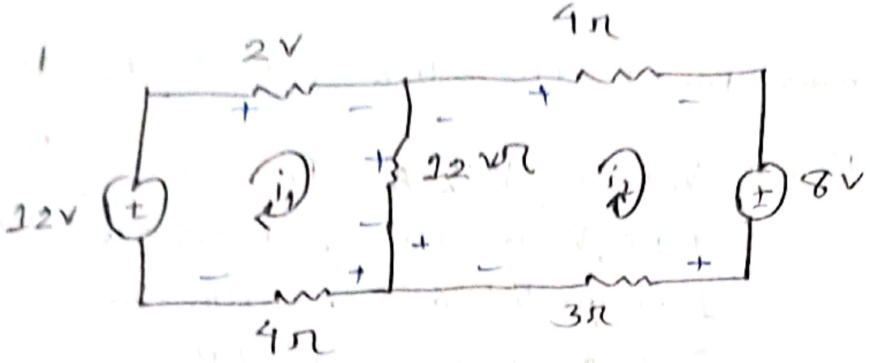
[+, − হলে + বিবেচনা করছি]

$i_1 = 1A$, $i_2 = 1A$ $i_3 = i_1 - i_2 = 0A$

$I_1 = i_1 = 1A$, $I_2 = i_2 = 1A$ [i_1, i_3 এর দিক-নিচে]

[5Ω মধ্যে] [6Ω মধ্যে]

Practice - 3.5



→ এখানে যদি ① 2A এর voltage source থাকে সেটির Equation নিয়ে হবে না এটা যদি থাকে থাকতো =) এগুলো super mesh

Find mesh currents i_1, i_2

Ans:

Mesh - 1:

$$12 - 2i_1 - 12(i_1 - i_2) - 4i_1 = 0$$

$$\Rightarrow -18i_1 + 12i_2 = -12 = 0 \quad \text{— (i)}$$

Mesh - 2:

$$-12(i_2 - i_1) - 4i_2 - 8 - 3i_2 = 0$$

$$\Rightarrow 12i_1 - 24i_2 = 8 \quad \text{— (ii)}$$

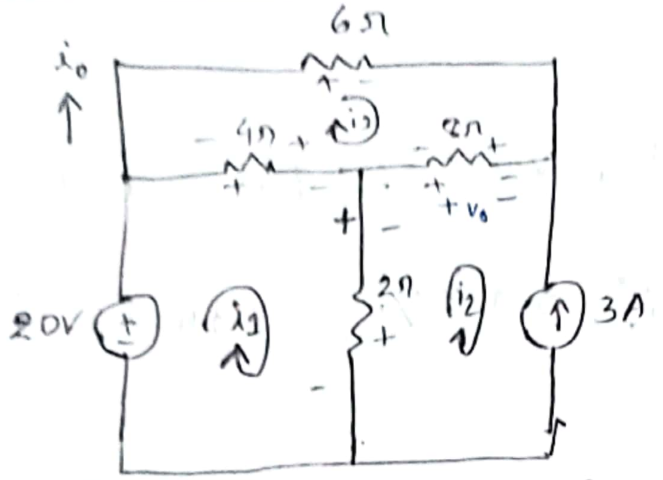
$$i_1 = 0.67A, \quad i_2 = 0A$$

$$V_{\text{across } 2\Omega} = 2 \times i_2 = 0\,V$$

$$P_{2\Omega} = i_1^2 \times 2 = 0.67^2 \times 2\,W$$

$$P_{12\Omega\,(\text{common})} = (i_1 - i_2)^2 \times 12 \quad \text{অথবা} \quad (i_2 - i_1) \times 12$$

Practice - 3.6 (modified)



(১) লুপ কয়টা?
(২) sign দেওয়া
(৩) Equation লিখো

Find mesh currents and i_o

Ans:

$i_2 = -3A$

Mesh-1:

$20 - 4(i_1 - i_3) - 2(i_1 - i_2) = 0$

$\Rightarrow -6i_1 + 2i_2 + 4i_3 = -20$

$\Rightarrow -6i_1 + 4i_3 = -20 + 6$

$\Rightarrow -6i_1 + 4i_3 = -14$ —— (i)

Mesh-3:

$-6i_3 - 8(i_3 - i_2) - 4(i_3 - i_1) = 0$

$\Rightarrow -6i_3 - 8i_3 - 24 - 4i_3 + 4i_1 = 0$

$\Rightarrow 4i_1 - 18i_3 = 24$ —— (ii)

$i_1 = 1.70A$

$i_3 = -0.96A$

$i_2 = -3A$

$i_o = i_3 = -0.96A$

Voltage across 8Ω, $V_{8\Omega} = 8 \times (i_2 - i_3)$

কারণ + V_0 - এটি i_2 তে অবস্থিত

Voltage across 2Ω, $V_{2\Omega} = 2 \times (i_2 - i_1)$

$P_{2\Omega} = (i_2 - i_1)^2 \times 2$