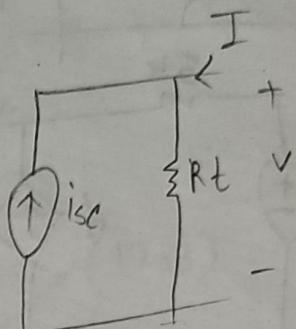
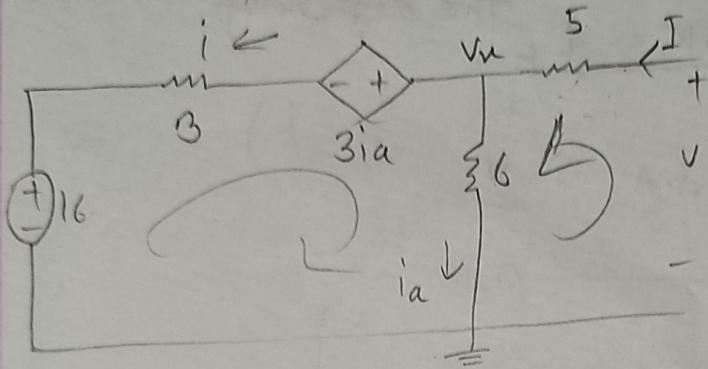


problem 5 ) find  $R_t$  and  $i_{sc}$



$$(I + i_{sc})R_t = V$$

$$i_a = \frac{v_n}{6}$$

$$\Rightarrow I = \frac{V}{R_t} - i_{sc}$$

$$-16 - 3i + 3ia + v_n = 0$$

$$-16 - 3i + 3ia + 6i_a = 0$$

$$\Rightarrow v_n = 3ia + 3i + 16$$

$$\Rightarrow -16 - 3i + 3ia + 6i_a = 0$$

$$\Rightarrow v_n = 3 \frac{v_n}{6} + 3 \left( I - \frac{v_n}{6} \right) + 16$$

$$\Rightarrow v_n = \frac{v_n}{2} + 3I - \frac{v_n}{2} + 16$$

$$\Rightarrow v_n = 3I + 16 \quad \text{---} \textcircled{1}$$

$$\Rightarrow 7.5I + v_n = 0$$

$$\Rightarrow v_n = -5I + v \quad \text{---} \textcircled{11}$$

$$\textcircled{1}, \textcircled{11} \Rightarrow$$

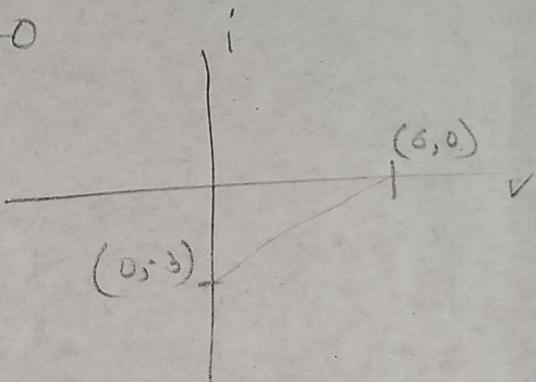
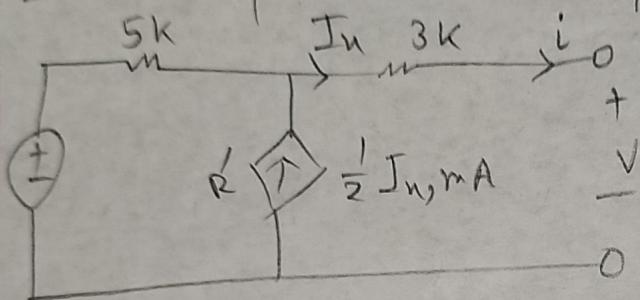
$$-5I + v = 3I + 16$$

$$\Rightarrow 8I = v - 16$$

$$\Rightarrow I = \frac{v - 16}{8}$$

$$R_t = 8 \Omega, i_{sc} = 2$$

problem 7 | Determine the resistance contributed by the dependent source.



$$\frac{1}{R} = -\frac{3}{6}$$

$$\Rightarrow R = -2 \text{ k}\Omega$$

$$5//R' + 3 = 2$$

$$\Rightarrow \left( \frac{R'+5}{5R'} \right)^{-1} = -1$$

$$\Rightarrow R' + 5R' + 5 = 0$$

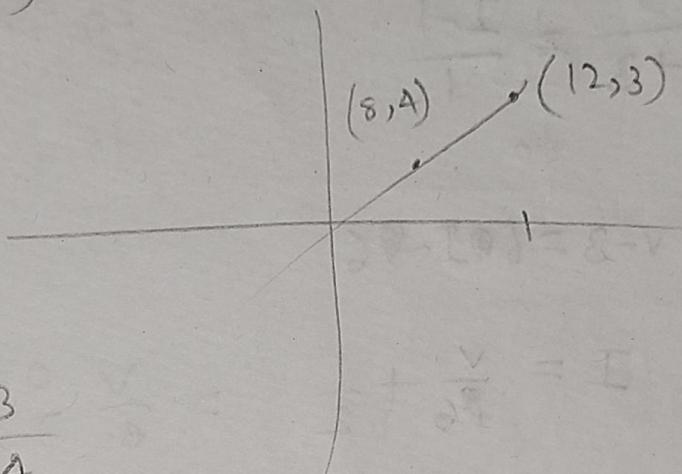
$$\Rightarrow R' = -\frac{5}{6} \text{ k}\Omega$$

$(24, 0)$   
 $(0, 12)$

$$V = \text{ ( } i = 4 \text{ ) }$$

$$(0, 8) \rightarrow (4, 8)$$

$$V = \text{ ( } i = 3 \text{ ) }$$



$$\frac{V-12}{12-8} = \frac{i-3}{3-4}$$

$$\Rightarrow \frac{V-12}{4} = 3-i$$

$$\Rightarrow V-12 = 12-i$$

$$\Rightarrow 4i = 24-V$$

$$\Rightarrow i = -\frac{1}{4}V + 6$$

~~$\frac{V-10}{10} = \frac{i-4}{4+6}$~~

~~$\frac{i+4}{4-6}$~~

$$(I+Iy) R_y = V$$

$$\Rightarrow I+Iy = \frac{V}{R_y}$$

$$\Rightarrow I = \frac{V}{R_y} - Iy$$

$$(3,1) (-3,0)$$

$$\frac{V-3}{3+3} = \frac{I-1}{1}$$

$$\Rightarrow V-3 = 6I - 6$$

$$\Rightarrow I = \frac{V}{6} + \frac{1}{2} = \frac{V}{6} - \frac{(-3)}{6}$$

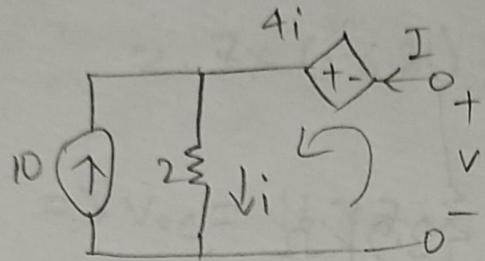
$$6IR + 3 = 6$$

$$\Rightarrow \frac{6R}{6+R} = 3$$

$$\Rightarrow 6R - 3R = 18$$

$$\Rightarrow 3R = 18$$

$$\Rightarrow R = 6 \Omega$$



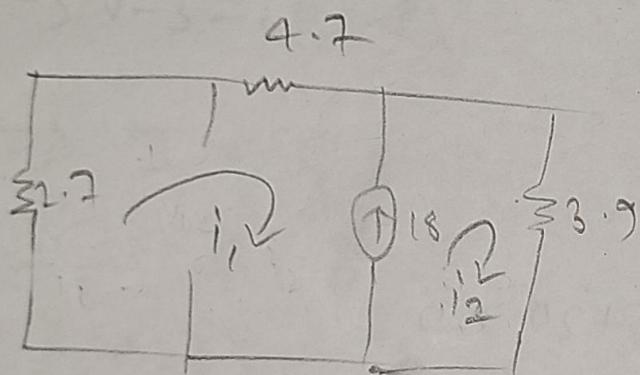
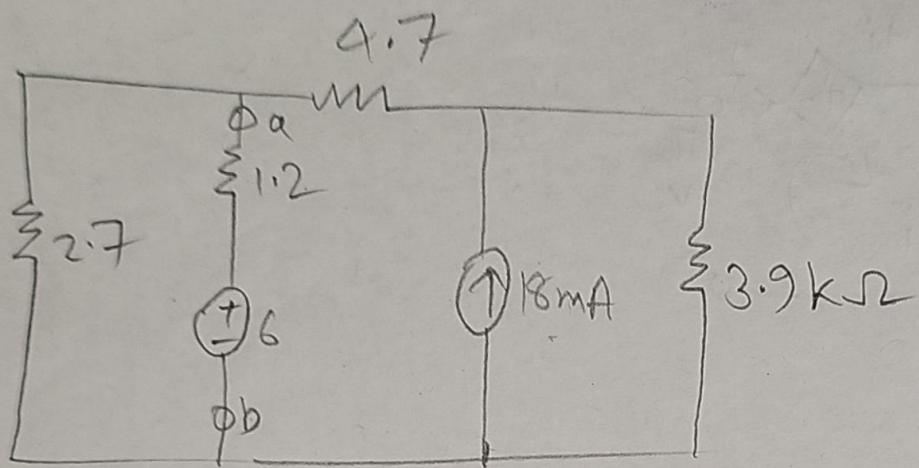
$$i = I + 10$$

$$-V - 4i + 2i = 0$$

$$\Rightarrow -V - 4I - 40 + 2I + 20 = 0$$

$$\Rightarrow 2I = -V - 20$$

$$\Rightarrow I = -\frac{V}{2} - 10$$



$$i_2 - i_1 = 18 \Rightarrow i_2 = i_1 + 18$$

Super mesh

$$2.7i_1 + 4.7i_1 + 3.9i_2 = 0$$

$$\Rightarrow 2.7i_1 + 4.7i_1 + 3.9i_1 + 70.2 = 0$$

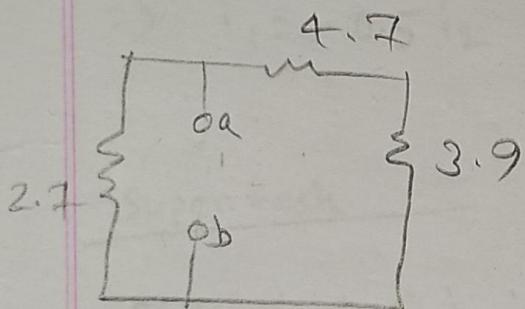
$$\Rightarrow i_1 = -6.21 \text{ mA}$$

$$\therefore i_2 = 11.79 \text{ mA}$$

$$\therefore 2.7 \times (-6.21) = -V_{oc}$$

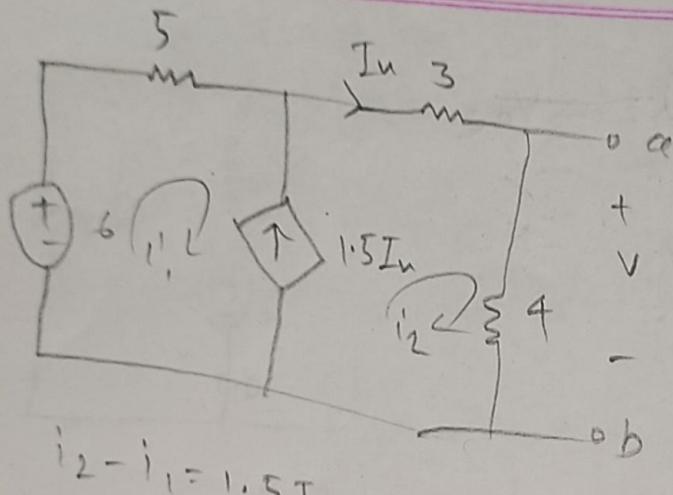
$$\Rightarrow V_{oc} = 16.77 \text{ V}$$

$$\therefore V_{th} = 16.77 \text{ V}$$



$$R_{th} =$$

6



$$i_2 - i_1 = 1.5 I_n$$

$$\Rightarrow i_2 - i_1 = 1.5 i_2$$

$$\Rightarrow i_2 = -\frac{i_1}{1.5} \Rightarrow i_1 = -1.5 i_2$$

mesh 1; 2

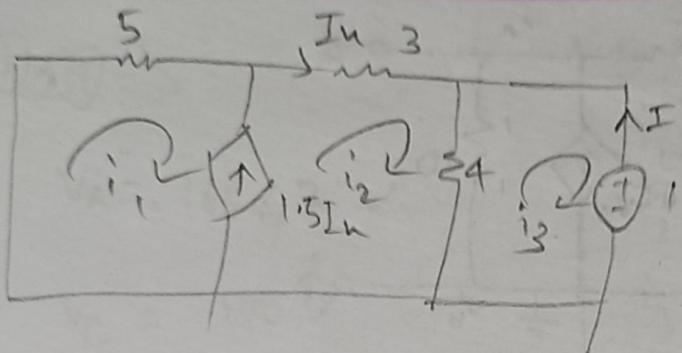
$$-6 + 5i_1 + 3i_2 + 4i_2 = 0$$

$$\Rightarrow -5(-1.5i_2) + 3i_2 + 4i_2 = 6$$

$$\therefore i_2 = -1.33$$

$$\therefore i_1 = 0.65$$

$$\left. \begin{array}{l} \therefore -v + 4i_2 = 0 \\ \Rightarrow v = 5.32V \end{array} \right\} \therefore V_{Th} = 5.32V$$



$$i_2 - i_1 = 1.5 I_n$$

$$\Rightarrow i_1 = -0.5 i_2$$

Supermesh

$$5i_1 + 3i_2 + 4(i_2 - i_3) = 0$$

$$\Rightarrow -2.5i_2 + 3i_2 + 4i_2 - 4i_3 = 0$$

$$\Rightarrow 4.5i_2 - 4i_3 = 0 \quad \textcircled{1}$$

Loop 3

$$1 + 4(i_3 - i_2) = 0$$

$$\Rightarrow -4i_2 + 4i_3 = -1 \quad \textcircled{2}$$

$$\textcircled{1}, \textcircled{2} \Rightarrow$$

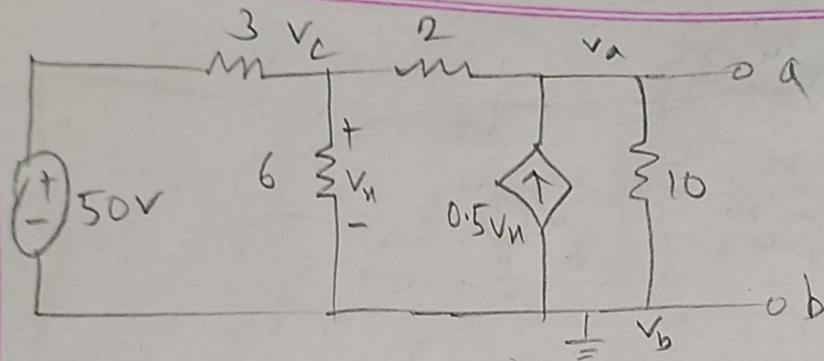
$$i_2 = -2, i_3 = -2.25$$

$$I = 2.25$$

$$\therefore R_{th} = \frac{1}{2.25}$$

$$= 0.44 \Omega$$

7



$$V_D = 0, \quad V_H = V_C$$

node a

$$V_a \left( \frac{1}{10} + \frac{1}{2} \right) - \frac{1}{2} V_C - 0.5 V_C = 0$$

$$\Rightarrow \frac{3}{5} V_a - V_C = 0$$

$$\Rightarrow 3V_a - 5V_C = 0 \quad \text{--- (1)}$$

node C

$$V_C \left( \frac{1}{2} + \frac{1}{3} + \frac{1}{6} \right) + \frac{50}{3} - \frac{V_a}{2} = 0$$

$$\Rightarrow -\frac{V_a}{2} + V_C = +\frac{50}{3} \quad \text{--- (2)}$$

①, ⑦  $\Rightarrow$

$$V_a = -166.67 \text{ V}$$

$$V_C = -100 \text{ V}$$

①, ⑪, ⑫, ⑯  $\Rightarrow$

$$i_1 = -0.167$$

$$i_2 = -0.25$$

$$i_3 = 0$$

$$i_4 = -0.1$$



$$V_u = 6(i_2 + i_1)$$

$$0.5V_u = i_3 - i_2$$

$$\Rightarrow -3i_2 + 3i_1 = i_3 - i_2$$

loop 1

$$3i_1 + 6(i_1 + i_2) = 0 \Rightarrow 3i_1 + 2i_2 + i_3 = 0 \quad \text{---} \textcircled{①}$$

$$\Rightarrow 9i_2 - 6i_2 = 0 \quad \text{---} \textcircled{⑩}$$

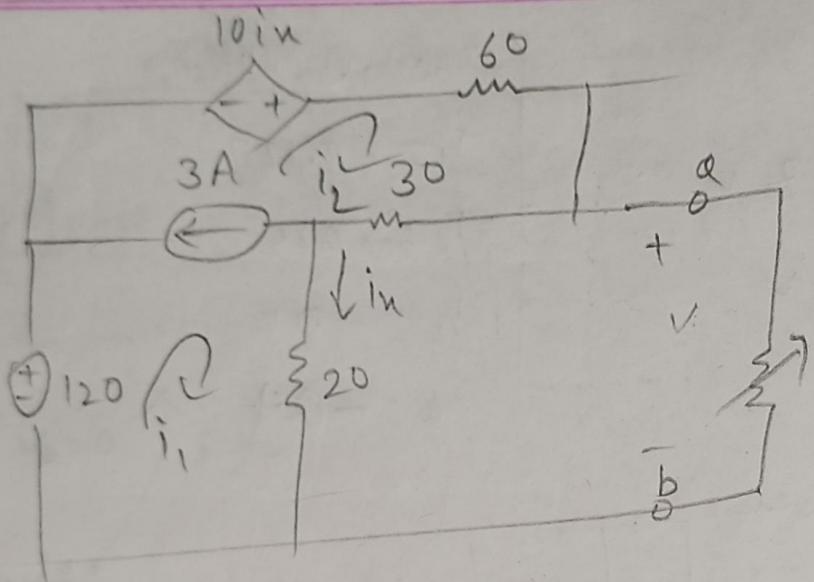
sup mesh

$$6(i_2 - i_1) + 2i_2 + 10(i_3 - i_4) = 0$$

$$\Rightarrow -6i_1 + 8i_2 + 10i_3 - 10i_4 = 0 \quad \text{---} \textcircled{⑫}$$

loop 4

$$14(i_4 - i_3)10 = 0 \Rightarrow -10i_3 + 10i_4 = -1 \quad \text{---} \textcircled{⑬}$$



$$i_2 - i_1 = 3, \quad i_{in} = i_1$$

supermesh ①

$$-120 - 10i_1 + 60i_2 + 30i_2 + 20i_1 = 0$$

$$\Rightarrow 10i_2 + 90i_2 = 120 \quad \text{---} ②$$

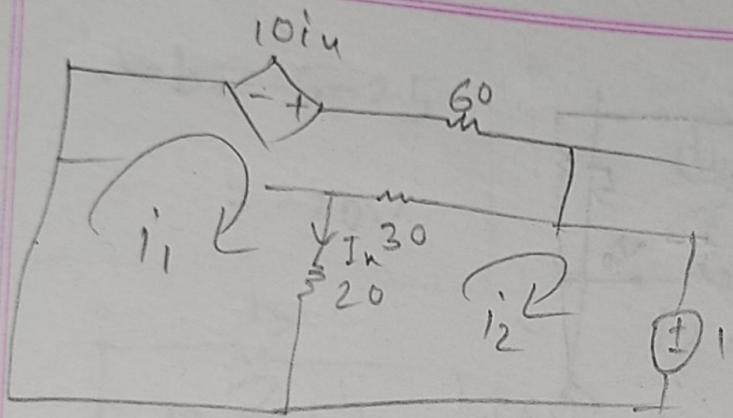
$$①, ② \Rightarrow$$

$$i_1 = -1.5$$

$$i_2 = 1.5$$

$$\therefore V = 15$$

$$\therefore V_{th} = 15V$$



$$i_n = i_1 - i_2$$

loop 1

$$-10(i_1 - i_2) + 60i_1 + 30(i_1 - i_2) + 20(i_1 - i_2) = 0$$

$$\Rightarrow 100i_1 - 40i_2 = 0$$

$$\Rightarrow 10i_1 - 4i_2 = 0 \quad \text{--- (1)}$$

loop 2

$$1 + 20(i_2 - i_1) + 30(i_2 - i_1) = 0$$

$$\Rightarrow -50i_1 + 50i_2 = -1 \quad \text{--- (2)}$$

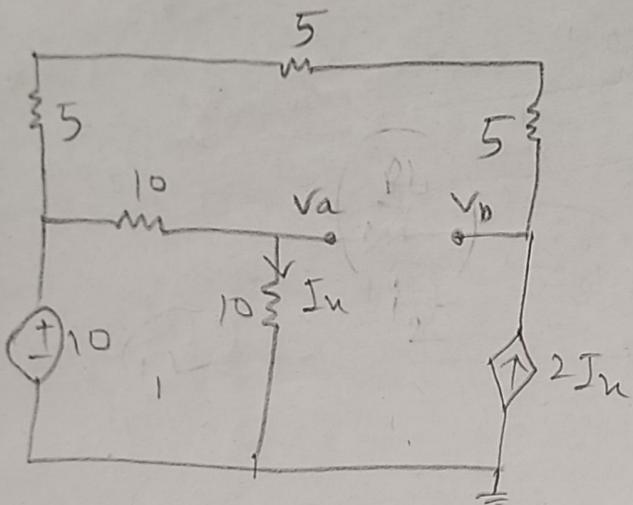
(1), (2)  $\Rightarrow$

$$i_1 = -0.0133$$

$$i_2 = -0.033$$

$$R_{th} = 30 \parallel 20 \Omega$$

9



$$I_n = \frac{V_a}{10}$$

node a

$$V_a \left( \frac{1}{10} + \frac{1}{10} \right) - \frac{10}{10} - \frac{0}{10} = 0$$

$$\Rightarrow V_a = 5V$$

node b

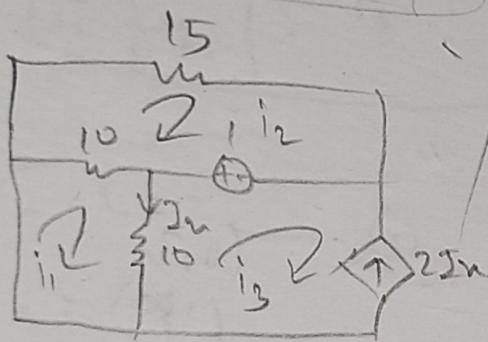
$$-2I_n + V_b \frac{1}{5} - \frac{10}{15} = 0$$

$$\Rightarrow -2 \frac{5}{10} + V_b \frac{1}{15} - \frac{10}{15} = 0$$

$$\Rightarrow V_b = 25$$

$$\therefore V_{ab} = 5 - 25$$

$$= -20V$$



$$\textcircled{1}, \textcircled{2}, \textcircled{3} \Rightarrow$$

$$i_1 = -0.1$$

$$i_2 = 0$$

$$i_3 = -0.2$$

$$\therefore R_{Th} = \frac{1}{0.2} = 5\Omega$$

$$I_u = i_1 - i_3 \quad , \quad i_3 = -2 I_u$$

$$\Rightarrow i_3 = -2i_1 + 2i_2$$

$$\Rightarrow 2i_1 - i_2 = 0 \quad \textcircled{1}$$

Loop 1

$$10(i_1 - i_2) + 10(i_1 - i_3) = 0$$

$$\Rightarrow 20i_1 - 10i_2 - 10i_3 = 0 \quad \textcircled{a}$$

Loop 2

$$-15i_2 + 1 + 10(i_2 - i_1) = 0$$

$$\Rightarrow -10i_1 + 25i_2 = 1 \quad \textcircled{b}$$

$$\frac{v-1}{1} = \frac{I-4}{4-3}$$

$$\Rightarrow v = I - 3$$

$$\Rightarrow I = v + 3$$

$(0,3)$   
 $(1,4)$

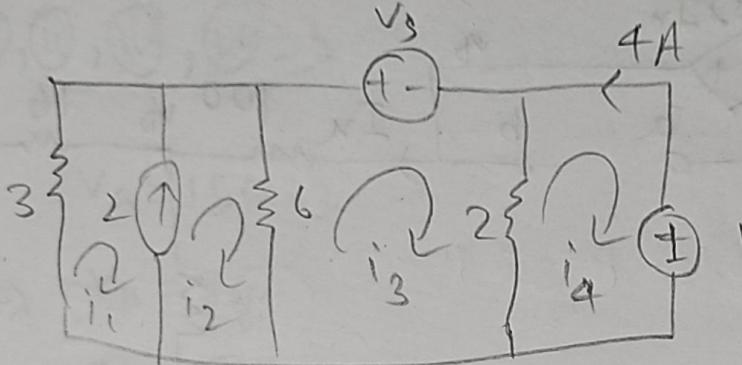
$$r = \left( \frac{3-4}{0-1} \right)^{-1} = 1$$

$$\left\{ \begin{array}{l} 3 \\ 6 \\ 1 \end{array} \right\} \quad \left\{ \begin{array}{l} R_u \\ \left( \frac{1}{3} + \frac{1}{6} + \frac{1}{R_u} \right)^{-1} = 1 \end{array} \right\} \quad \therefore R_u = 2$$

$$\frac{6/R_u/3}{3+R_u+6} = -1 \rightarrow$$

$$\cancel{\therefore R_u = -12}$$

$$\therefore R_u =$$



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

$$i_4 = -4$$

$$(1), (11) \Rightarrow$$

$$i_2 = \frac{-5}{3}$$

Supermesh

$$i_1 = \frac{11}{3}$$

$$3i_1 + 6(i_2 - i_3) = 0$$

$$\Rightarrow 6i_2 + 3i_1 - 6i_3 = 0 \quad \text{--- loop 3, } V_3 + 2(i_3 - i_4) + 6(i_3 - i_2) = 0$$

$$\Rightarrow 2i_2 + i_1 - 2i_3 = 0$$

$$\Rightarrow 2i_2 + i_1 = 7 \quad \text{--- (11)}$$

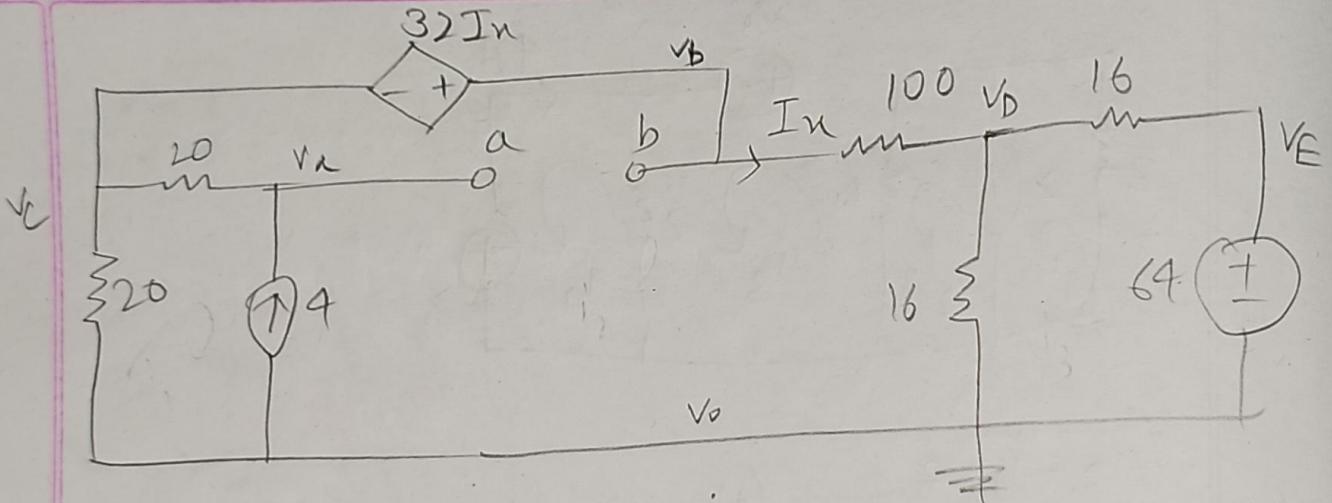
loop 4

$$V_4 + 2(-3.5 + 4) + 6\left(-3.5 + \frac{5}{3}\right) = 0$$

$$1 + 2(i_4 - i_3) = 0$$

$$\Rightarrow V_4 = 10 \text{ V}$$

$$\Rightarrow i_3 = -3.5$$



$$V_o = 0, V_E = 64, I_n = \frac{V_b - V_D}{100}$$

$$\therefore V_b - V_C = 32 - \frac{V_b - V_D}{100}$$

node a:

$$\left. \begin{aligned} V_a \frac{1}{20} - V_C \frac{1}{20} - 4 &= 0 \\ \Rightarrow V_a - V_C &= 80 \end{aligned} \right\} \Rightarrow 100V_b - 100V_C = 32V_b - 32V_D$$

$$\text{super node } b, c: 100V_b + 32V_D = 64$$

$$-V_C \left( \frac{1}{20} + \frac{1}{20} \right) - V_a \frac{1}{20} + V_b \frac{1}{100} - V_D \frac{1}{100} = 0$$

$$\Rightarrow -5V_a + V_b + 10V_C - V_D = 0 \quad \textcircled{W}$$

Super node?

node D

$$V_D \left( \frac{1}{100} + \frac{1}{16} + \frac{1}{16} \right) - V_b \frac{1}{100} - 64 \frac{1}{16}$$

$$\Rightarrow -V_b + 13.5V_D = 400 \quad \textcircled{W}$$

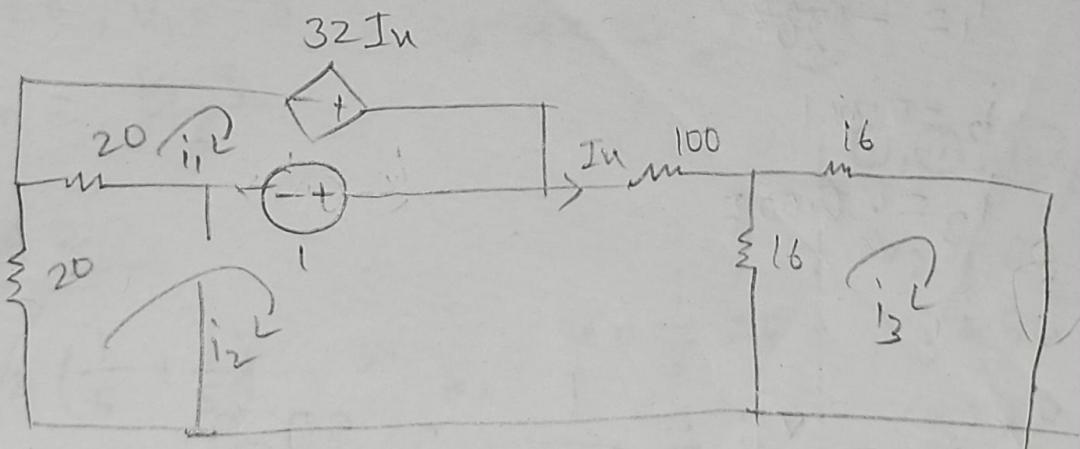
①, ⑩, ⑪, ⑫  $\Rightarrow$

$$V_a = 150 \angle 33^\circ$$

$$V_b = 86 \angle -21.81^\circ$$

$$V_c = 670 \angle 70^\circ$$

$$V_d = 367 \angle -81.83^\circ$$



$$I_n = i_2$$

loop 1

$$-32i_2 + 1 + 20(i_1 - i_2) = 0$$

$$\Rightarrow 20i_1 - 52i_2 = -1 \quad \text{--- } ①$$

loop 3

$$16i_3 + 16(i_3 - i_2) = 0$$

$$\Rightarrow -16i_2 + 32i_3 = 0 \quad \text{--- } ⑪$$

loop 2

$$20i_2 + 20(i_2 - i_1) - 1 + 100i_2 + 16(i_2 - i_3) = 0$$

$$\Rightarrow -20i_1 + 156i_2 - 16i_3 = 1 \quad \textcircled{W}$$

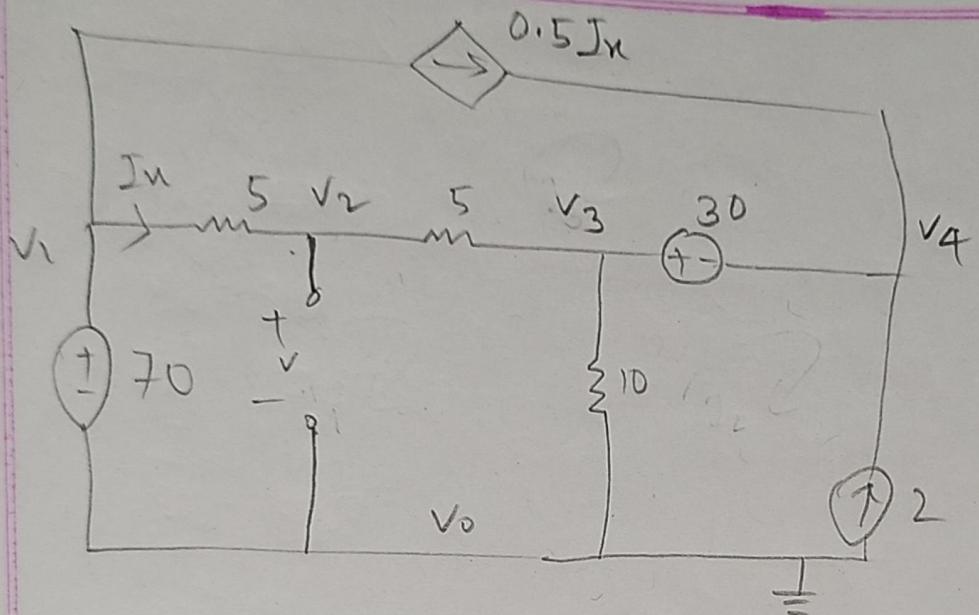
①, ②, ③, ④  $\Rightarrow$

$$i_1 = -\frac{1}{20}$$

$$i_2 = 0.001$$

$$i_3 = 0.005$$

$$\therefore R_A = \frac{V+1}{I} = \frac{1}{i_2 - i_1} = 120 \Omega$$



$$v_0 = 0, v_1 = 70 \rightarrow v_3 - v_4 = 30 \quad \textcircled{①}$$

$$I_n = \frac{v_1 - v_2}{5} \rightarrow I_n = 0$$

①, ②, ③,

node 2

$$v_2 \left( \frac{1}{5} + \frac{1}{5} \right) - v_1 \frac{1}{5} - v_3 \frac{1}{5} = 0$$

$$v_2 = 60$$

$$\Rightarrow 2v_2 - v_3 = 70 \quad \textcircled{④}$$

$$v_3 = 50$$

$$v_4 = 20$$

$$\therefore V = V_2 - V_0 \\ = 60V$$

supernode 3,4

$$v_3 \left( \frac{1}{5} + \frac{1}{10} \right) - v_2 \frac{1}{5} - 2 - 0.5 I_n = 0$$

$$\Rightarrow -v_2 \frac{1}{5} + v_3 \frac{3}{10} - 2 - 0.5 \frac{v_1 - v_2}{5} = 0$$

$$\Rightarrow -2v_2 + 3v_3 - 20 - 70 + v_2 = 0$$

$$\Rightarrow -v_2 + 3v_3 = 90 \quad \textcircled{⑤}$$