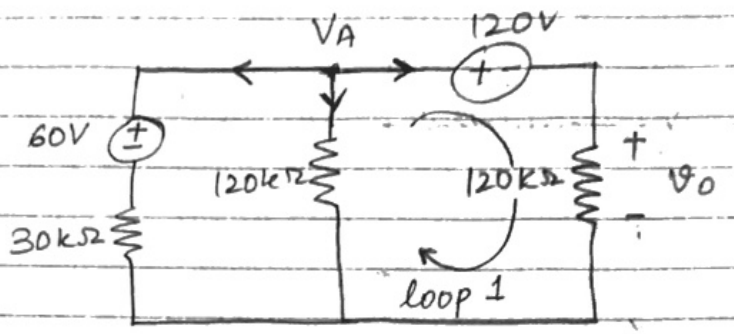
HW # 3

SOLUTIONS

Problems:

* 3.5
* 3.14
* 3.20
* 3.35
* 3.46
* 3.49
* 3.52.

3.5



Applying KCL at node A:

$$\frac{V_A - 60}{30k} + \frac{V_A - 120}{120k} + \frac{V_A}{120k} = 0$$

$$\Rightarrow 4V_A - 240 + V_A - 120 + V_A = 0$$

$$\Rightarrow 6V_A = 360$$

$$\Rightarrow \boxed{V_A = 60\ V.}$$

Appling KVL in loop 1:

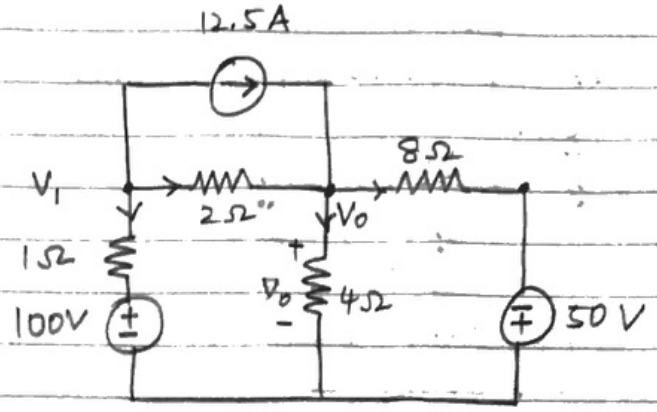
** Note: Voltage across 120k resistor = V_A.

$$-V_A + 120 + v_o = 0$$

$$\therefore -60 + 120 = -v_o$$

$$\therefore \boxed{v_o = -60\ V.}$$

3.14



Applying KCL at node 1 (V_1):

$$\frac{V_1 - 100}{1} + \frac{V_1 - V_o}{2} + 12.5 = 0$$

$$\Rightarrow 3V_1 - V_o = 175 \quad - (1)$$

Applying KCL at node o (V_o):

$$-\frac{(V_1 - V_o)}{2} - 12.5 + \frac{V_o - (-50)}{8} + \frac{V_o}{4} = 0$$

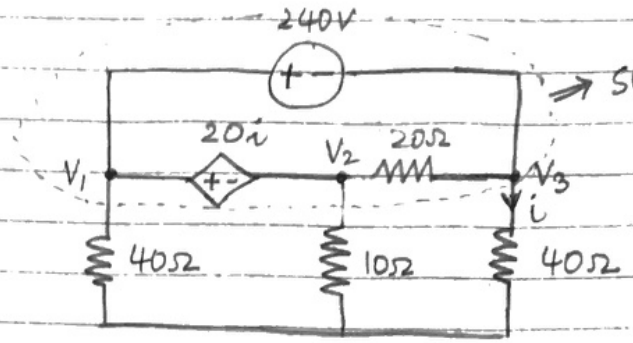
$$\Rightarrow 4V_1 - 4V_o - 100 + V_o + 50 + 2V_o = 0$$

$$\Rightarrow -4V_1 + 3V_o = 50 \quad - (2)$$

Solving eq^n: (1) + (2) we get:

$$\boxed{\begin{aligned} V_1 &= 75V \\ V_o &= 50V \end{aligned}}$$

3.20



First at V_3: $i = \frac{V_3}{40}$ — (1)

For the entire supernode:

1st constraint eqn:

$V_1 - V_3 = 240$

$\Rightarrow V_3 = V_1 - 240$ — (2)

2nd constraint eq: $V_1 - V_2 = 20i$

$= 20\left(\frac{V_3}{40}\right)$ (From (1))

$= \frac{V_1 - 240}{2}$ (From (2))

$\Rightarrow V_2 = \frac{V_1 + 240}{2}$ — (3)

Applying KCL at the supernode:

$$\frac{V_1}{40} + \frac{V_2}{10} + \frac{V_3}{40} = 0$$

$$\Rightarrow \frac{V_1}{40} + \frac{V_1 + 240}{20} + \frac{V_1 - 240}{40} = 0$$

(From (2) & (3))

$$\Rightarrow V_1 + 2V_1 + 480 + V_1 - 240 = 0$$

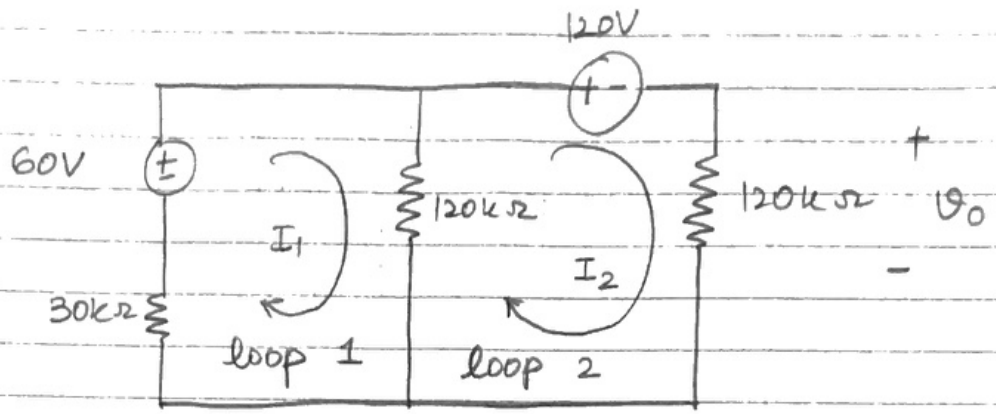
$$\Rightarrow 4V_1 = -240$$

$$\Rightarrow \boxed{V_1 = -60\ V}$$

$\therefore V_2 = 90V$

$V_3 = -300V$

3.35



Applying KVL in loop 1:

$$30k\,I_1 - 60 + 120k(I_1 + I_2) = 0$$
$$\Rightarrow \quad 150k\,I_1 - 120k\,I_2 = 60V \quad -(1)$$

Applying KVL in loop 2:

$$120k(I_2 - I_1) + 120V + 120k(I_2) = 0$$
$$\Rightarrow \quad -120k\,I_1 + 240k\,I_2 = -120V \quad -(2)$$

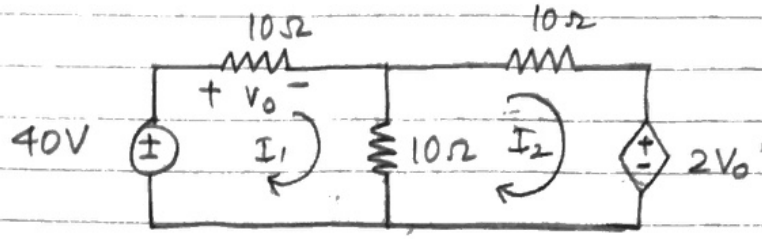
Solving eqn: (1) & (2) we get:

$$I_1 = 0A \;;\; I_2 = -0.5\,mA$$

Now,

$$v_o = 120k \times (I_2)$$
$$= \boxed{-60V}$$

3.46



By inspection : $V_o = 10 . I_1$ — (1)

By applying KVL in loop 1 :

$$-40 + 10I_1 + 10(I_1 - I_2) = 0$$

$$\Rightarrow 20I_1 - 10I_2 = 40V \quad - (2)$$

By applying KVL in loop 2 :

$$10(I_2 - I_1) + 10I_2 + 2V_o = 0$$

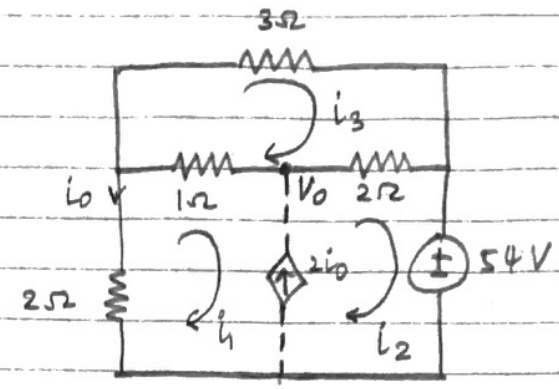
$$\Rightarrow -10I_1 + 20I_2 + 2(10I_1) = 0 \quad \text{(From (1))}$$

$$\Rightarrow 10I_1 + 20I_2 = 0 \quad - (3)$$

Solving eq^n (2) & (3) we get :

$$I_1 = 1.6\ A$$
$$I_2 = -0.8\ A$$

3.49



Loops 1 and 2 form a supermesh:

Constraint eqn.: $i_2 - i_1 = 2i_o$ — ①

By inspection: $i_1 = -i_o$ — ②

From ① and ②

$i_2 - i_1 = -2i_o$

$\Rightarrow i_2 = -i_1$ — ③

Applying KVL to the supermesh:

$1\times(i_1 - i_3) + 2(i_2 - i_3) + 54 + 2i_1 = 0$

$\Rightarrow i_1 - 3i_3 = -54$ (Using eqn. ③) — ④

Applying KVL to loop 3:

$3i_3 + 2(i_3 - i_2) + 1(i_3 - i_1) = 0$

$\Rightarrow i_1 + 6i_3 = 0$ — ⑤

Solving eqn. ④ and ⑤, we get:

$i_1 = -36$ A

$i_3 = 6$ A

$\therefore$ From ②: $i_o = 36$A

Applying KVL to loop 1.

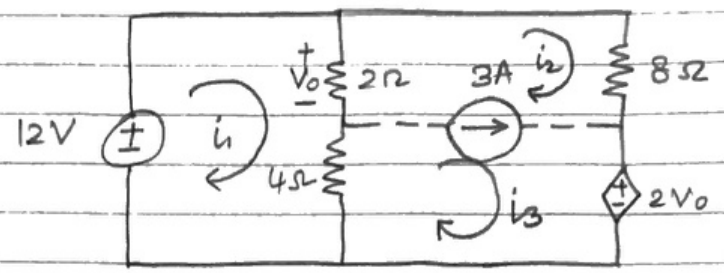
**Note: Voltage across current source = V_o

$$1(i_1 - i_3) + V_o + 2i_L = 0$$

$$\therefore V_o = i_3 - 3i_1$$

$$= \boxed{114\,V}$$

3.52



Loops 2 and 3 form a supermesh:

Constraint eqⁿ for supermesh:

$$i_3 - i_2 = 3A \quad - (1)$$

By inspection: $2(i_1 - i_2) = V_o \quad - (2)$

Applying KVL to the supermesh:

$$4(i_3 - i_1) + 2(i_2 - i_1) + 8i_2 + 2V_o = 0 \quad - (3)$$

From (2) and (3):

$$8i_2 + 4(i_1 - i_2) + 4(i_3 - i_1) + 2(i_2 - i_1) = 0$$

$$-2i_1 + 6i_2 + 4(i_2 + 3) = 0 \quad (\text{From } (1))$$

$$\Rightarrow -2i_1 + 10i_2 = -12 \quad - (4)$$

Applying KVL to loop 1:

$$2(i_1 - i_2) + 4(i_1 - i_3) - 12 = 0$$

$$\Rightarrow 6i_1 - 6i_2 = +24 \quad (\text{From } (1)) \quad - (5)$$

Solving (4) and (5)

$i_1 =$	3.5 A
$i_2 =$	−0.5 A
$i_3 =$	2.5 A