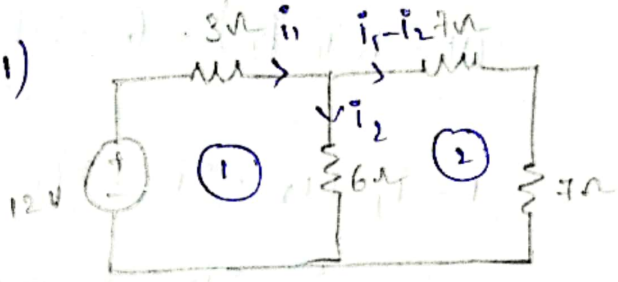
05/01

AEC Practice Problems

Q 1)



Apply KVL in loop 1,

$$12V - 3i_1 - 6i_2 = 0$$

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

Apply KVL in loop 2,

$$-7(i_1 - i_2) - 7(i_1 - i_2) + 6i_2 = 0$$

$$14(i_1 - i_2) - 6i_2 = 0$$

$$14i_1 - 20i_2 = 0$$

$$i_1 = \frac{10}{7} i_2$$

(1) $\Rightarrow$ $\frac{10}{7} i_2 + 2i_2 = 4$

$$i_2 \left(\frac{24}{7}\right) = 28$$

$$i_2 = \frac{28}{24}$$

$$\boxed{i_2 = 1.16\,A}$$

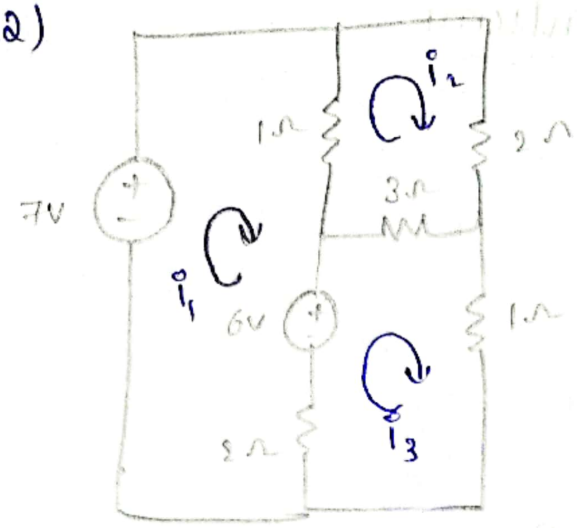
$\Rightarrow$ $i_1 = \frac{10}{7} \times \frac{28}{24}$

$$\boxed{i_1 = 1.66\,A}$$

$$i_1 - i_2 = 1.66 - 1.16 = 0.5\,A$$

$\Rightarrow$ $i_{6\Omega} = 1.16A$ | $i_{7\Omega} = 0.5A$ | $i_{3\Omega} = 1.66A$

Q2)



In loop 1

$$7V - 1(i_1 - i_2) - 6 - 2(i_1 - i_3) = 0$$

$$1 - i_1 + i_2 - 2i_1 + 2i_3 = 0$$

$$3i_1 - i_2 - 2i_3 = 1 \quad \text{—(1)}$$

In loop 2,

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

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

In loop 3,

$$+6 - 3(i_3 - i_2) - i_3 + 2(i_3 - i_1) = 0$$

$$6 - 2i_3 + 3i_2 - 2i_1 = 0$$

$$2i_1 - 3i_2 + 2i_3 = 6 \quad \text{—(3)}$$

(1) + (3)

$$5i_1 - 4i_2 = 7 \quad \text{—(4)}$$

~~(2) x 2 + (3)~~

$$2i_1 - 12i_2 + 6i_3 = 0$$
$$2i_1 - 3i_2 + 2i_3 = 6$$
$$-9i_2$$

(2) x 2 + (3) x 3

$$2i_1 - 12i_2 + 6i_3 = 0$$
$$6i_1 - 9i_2 + 6i_3 = 18$$
$$-4i_1 - 3i_2 = -18$$

$$4i_1 + 3i_2 = 18 \quad (5)$$

④ × 3 + ⑤ × 4

$$15i_1 - 12i_2 = 21$$
$$16i_1 + 12i_2 = 72$$
$$31i_1 = 93$$

$$\boxed{i_1 = 3A}$$

$$i_2 = \frac{18 - 4(3)}{3} = \frac{6}{3}$$

$$\boxed{i_2 = 2A}$$

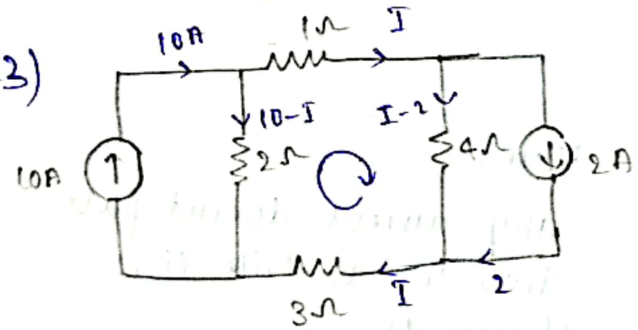
② ⇒ $3i_3 = 6i_2 - i_1$

$$i_3 = \frac{12 - 3}{3} =$$

$$\boxed{i_3 = 3A}$$

$\therefore$ $i_1 = 3A$; $i_2 = 2A$; $i_3 = 3A$

Q3)



Solve, the middle loop

$$+I + 4(I-2) + 3I = (10-I)2$$

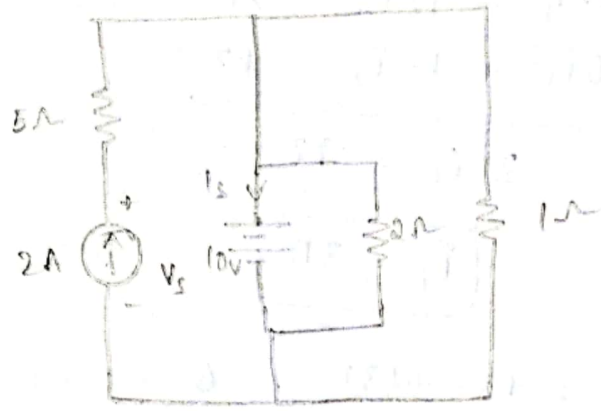
$$+8I + 8 = 20 - 2I$$

$$10I = 28$$

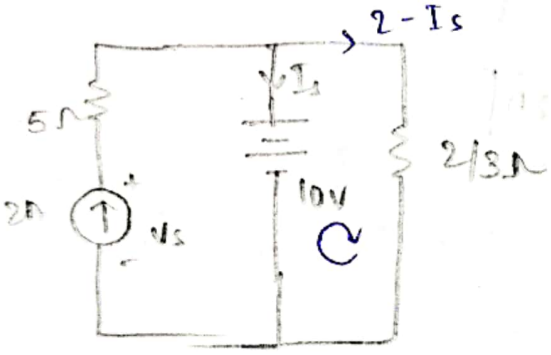
$$I = \frac{28}{10}$$

$$\boxed{I = 2.8\,A}$$

Q4)



2 + 1



In loop 2

$$10V = \frac{5}{3}(2 - I_s)$$

$$15 = 2 - I_s$$

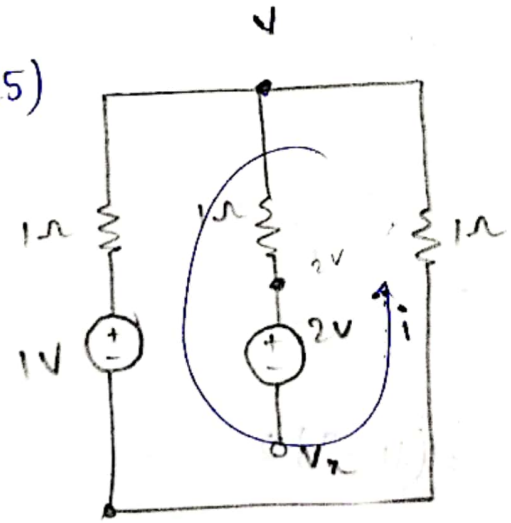
$$\boxed{I_s = -13A}$$

In loop (1)

$$V_s - 10 - 10 = 0$$

$$\boxed{V_s = 20V}$$

Q5)



Here,

any current doesn't pass into the middle line elements

Apply KCL in outer

$$-i + 1 - i = 0$$

$$2i = 1$$

$$i = 0.5A$$

$\Rightarrow$ Voltage at point V $= 1 - (0.5)(1\Omega)$

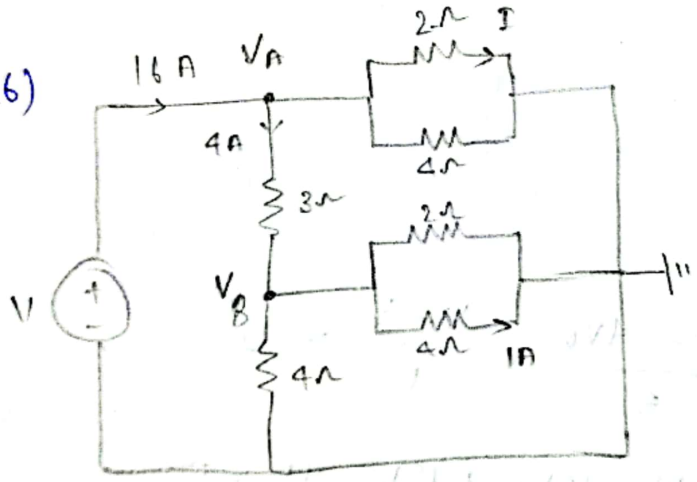
$= 0.5V$

⇒ At $V_x = V - 2V$

$= 0.5 - 2$

$\boxed{V_x = -1.5V}$.

Q6)



At Node A.

$$16 = \frac{V_A - V_B}{3} 4 + I + \frac{V_A}{4}$$

$$12 = \frac{V_A}{4} + I \quad \text{---(1)}$$

At Node B

$$4 = \frac{V_B}{4} + \frac{V_B}{2} + 1$$

$$3 = \frac{3V_B}{4} \qquad \boxed{V_B = 4}$$

also $\frac{V_A - V_B}{2} = 4$ $V_A = 12+4$ $\boxed{V_A = 16A}$

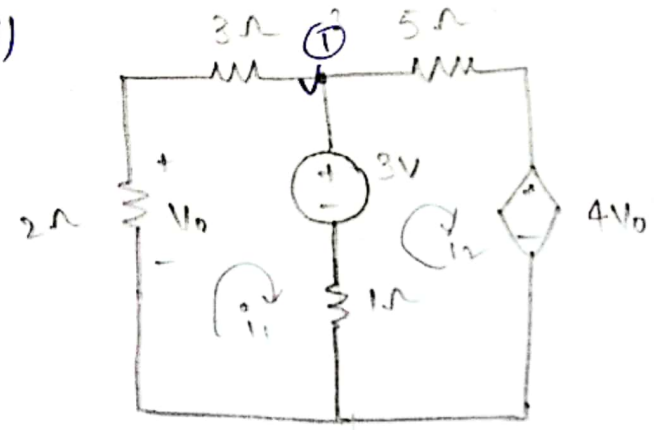
(1) $\Rightarrow$ $12 = \frac{8b}{4} + I$

$I = 12 - 4$

$\boxed{I = 8A}$

And $\boxed{V_n = V = 16V}$

Q.7)



At Node 1,

$$\frac{V - V_0}{3} + \frac{V - 4V_0}{5} + \frac{V - 3}{1} = 0$$

$$5V - 5V_0 + 3V - 12V_0 + 15V - 45 = 0$$

$$23V - 17V_0 - 45 = 0. \quad \text{—— (1)}$$

also, $\frac{V_0}{2} = \frac{V - V_0}{3}$

$5V_0 = 2V$

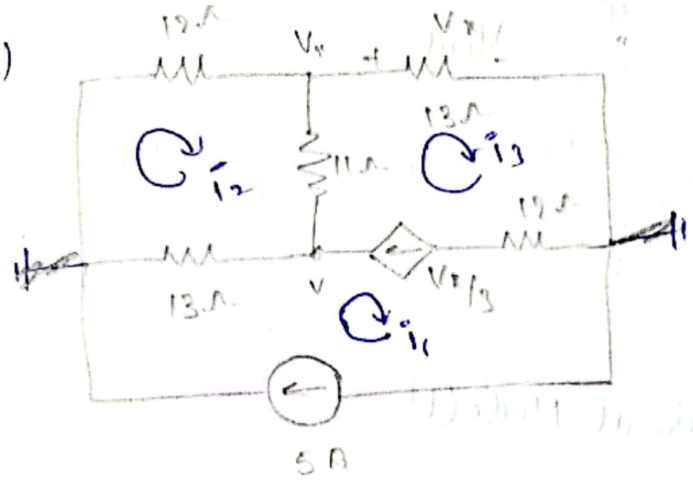
$V = \frac{5}{2} V_0$ —— put in (1)

(1) $\Rightarrow$ $\frac{5}{2}(23) V_0 - 17V_0 = 45$

$40.5\, V_0 = 45$

$\boxed{V_0 = 1.11\ V}$

Q8)



From above, we can say

$$i_1 = 5A$$

$$i_3 - i_1 = \frac{V_x}{3}$$

$$i_3 = \frac{V_x}{13}$$

$$\therefore \Rightarrow \frac{V_x}{13} - 5 = \frac{V_x}{3} \Rightarrow \frac{V_x}{13} - \frac{V_x}{3} = 5$$

$$\frac{3V_x - 13V_x}{39} = 5$$

$$\boxed{V_x = -\frac{39}{2} V}$$

$$i_3 = -\frac{39}{2(13)}$$

$$= -\frac{3}{2} A$$

In loop 2

$$-12i_2 - 11(i_2 - i_3) - 13(i_2 - i_1) = 0.$$

$$-36i_2 + 11\left(-\frac{3}{2}\right) + 13(5) = 0$$

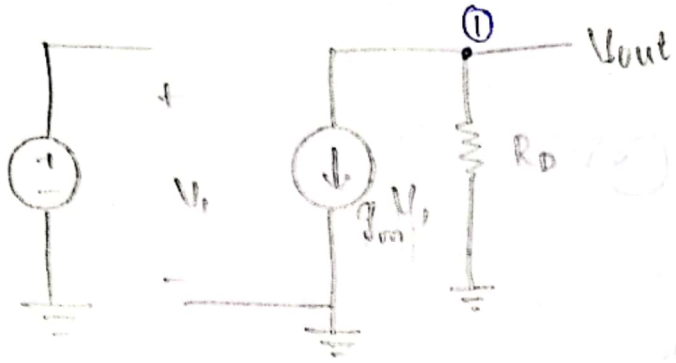
$$36i_2 = 48.5$$

$$\boxed{i_2 = 1.347 A}$$

& $i_{11} = i_2 - i_3 = 1.347 - (-1.5)$

$$\boxed{i_{11} = 2.85 A}$$

Q9)



Apply Nodal Analysis at Node ①

$$\frac{V_{out} - 0}{R_D} + g_m V_1 = 0$$

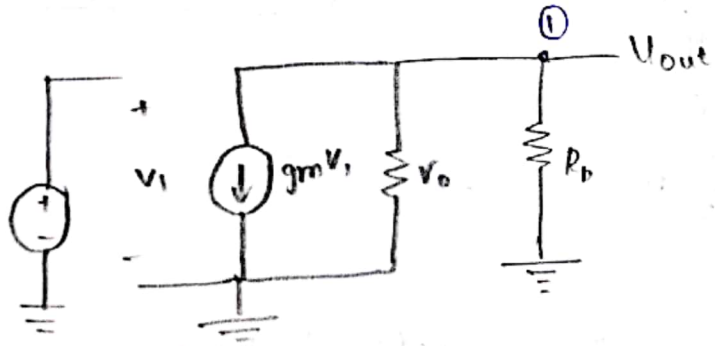
$$\frac{V_{out}}{R_D} = -g_m V_1$$

$$\frac{V_{out}}{V_1} = \frac{-g_m}{R_D}$$

Here, $V_1 = V_{in}$

$$\Rightarrow \boxed{\frac{V_{out}}{V_{in}} = \frac{-g_m}{R_D}}$$

Q10)



At Node ①,

$$\frac{V_{out} - 0}{R_D} + \frac{V_{out}}{r_o} + g_m V_1 = 0$$

$$V_{out}\left(\frac{r_o + R_D}{r_o R_D}\right) = -g_m V_1$$

$$\frac{V_{out}}{V_i} = -g_m (R_D \| r_o)$$

Similarly, here

$$V_1 = V_{in}$$

$$\Rightarrow \quad \frac{V_{out}}{V_{in}} = -g_m (R_D \| r_o)$$