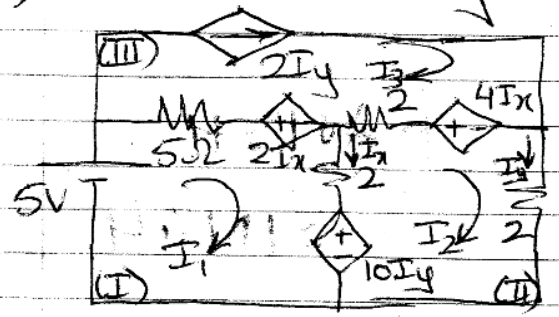
TYPE I: MESH ANALYSIS

Q1) Find I_x and I_y



$I_2 = I_y$ ——(I)

$I_x = I_1 - I_2$ ——(II)

By KVL to loop (I):-

$5 - 2I_x - 10I_y = 7I_1 - 2I_2 - 5I_3$

From (I) & (II)

$5 - 2(I_1 - I_2) - 10I_2 = 7I_1 - 2I_2 - 5I_3$

$\therefore 9I_1 + 6I_2 = 5$ ——(III)

By KVL to loop (II)

$10I_y - 4I_x = -2I_1 + 6I_2 - 2I_3$

From (I) & (II)

$10I_2 - 4(I_1 - I_2) = -2I_1 + 6I_2 - 2I_3$

$\therefore 2I_1 - 8I_2 - 2I_3 = 0$ ——(IV)

From loop (III)

(KVL cannot be applied to current source)

$I_3 = 2I_y$

From (I)

$I_3 = 2I_2$

$\therefore 0I_1 + 2I_2 - I_3 = 0$ ——(V)

$$\therefore \begin{bmatrix} 9 & +6 & -5 \\ 2 & -8 & -2 \\ 0 & 2 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 5 \\ 0 \\ 0 \end{bmatrix}$$

$$I_1 = \frac{\Delta_{I_1}}{\Delta} = \frac{\begin{vmatrix} 5 & +6 & -5 \\ 0 & -8 & -2 \\ 0 & 2 & -1 \end{vmatrix}}{\begin{vmatrix} 9 & +6 & -5 \\ 2 & -8 & -2 \\ 0 & 2 & -1 \end{vmatrix}}$$

$\therefore I_1 = 0.455 \approx 0.6$

$$I_2 = \frac{\Delta_{I_2}}{\Delta} = \frac{\begin{vmatrix} 9 & 5 & -5 \\ 2 & 0 & -2 \\ 0 & 0 & -1 \end{vmatrix}}{\begin{vmatrix} 9 & +6 & -5 \\ 2 & -8 & -2 \\ 0 & 2 & -1 \end{vmatrix}}$$

$\therefore I_2 = -0.057 \approx 0.1$

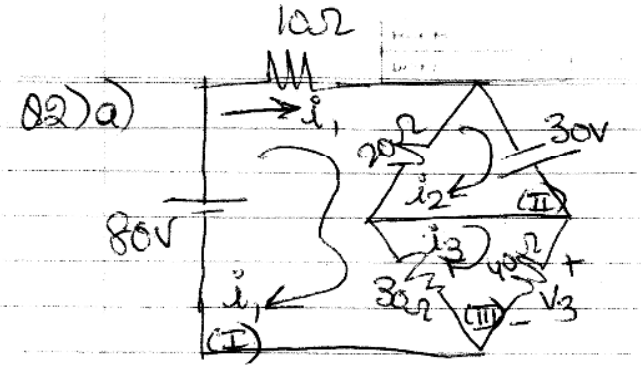
$$I_3 = \frac{\Delta_{I_3}}{\Delta} = \frac{\begin{vmatrix} 9 & +6 & 5 \\ 2 & -8 & 0 \\ 0 & 2 & 0 \end{vmatrix}}{\begin{vmatrix} 9 & +6 & -5 \\ 2 & -8 & -2 \\ 0 & 2 & -1 \end{vmatrix}}$$

$\therefore I_3 = -0.114 \approx 0.2$

$I_x = I_1 - I_2 = 0.512 \approx 0.5$

$I_y = I_2 = -0.057 \approx 0.1$

Q2) a)



By KVL to loop I:-

$$80 = 60i_1 - 20i_2 - 30i_3 \quad \text{—(I)}$$

By KVL to loop II:-

$$30 = -20i_1 + 20i_2 + 0i_3 \quad \text{—(II)}$$

By KVL to loop III:-

$$0 = -30i_1 + 0i_2 + 70i_3 \quad \text{—(III)}$$

$\therefore i_1 = 0.405$

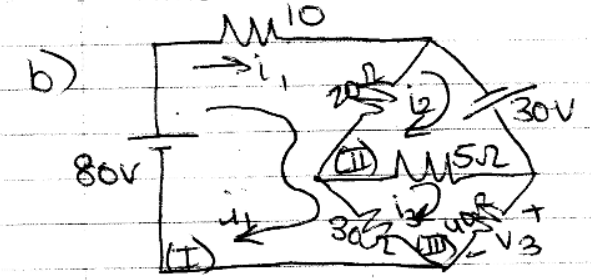
$i_2 = 5.553$

$i_3 = 1.737$

$V_3 = 40 i_3$

$= 69.48\ V$

b)



By KVL to loop I:-

$$80 = 60i_1 - 20i_2 - 30i_3 \quad \text{—(I)}$$

By KVL to loop II :-

$30 = -20i_1 + 25i_2 - 5i_3$ —(II)

By KVL to loop III :-

$0 = -30i_1 - 5i_2 + 75i_3$ —(III)

$\therefore i_1 = 3.7619$

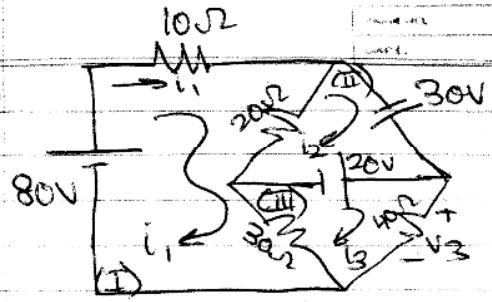
$i_2 = 4.5714$

$i_3 = 1.8095$

$V_3 = 40 i_3$

$= 72.38 V$

(c)



By KVL to loop I :-

$80 = 60i_1 - 20i_2 - 30i_3$ —(I)

By KVL to loop II :-

$10 = -20i_1 + 80i_2 + 0i_3$ —(II)

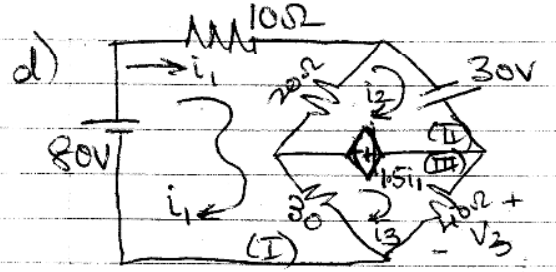
By KVL to loop III :-

$20 = -30i_1 + 0i_2 + 70i_3$ —(III)

$\therefore i_1 = 3.632$
$i_2 = 4.132$
$i_3 = 1.842$

$V_3 = 40 i_3$
$= 73.68$

d)



By KVL to loop I:-

$80 = 60i_1 - 20i_2 - 30i_3$ ——(I)

By KVL to loop II:-

$30 - 1.5i_1 = -20i_1 + 20i_2 + 0i_3$

$\therefore 30 = -18.5i_1 + 20i_2 + 0i_3$ ——(II)

By KVL to loop III:-

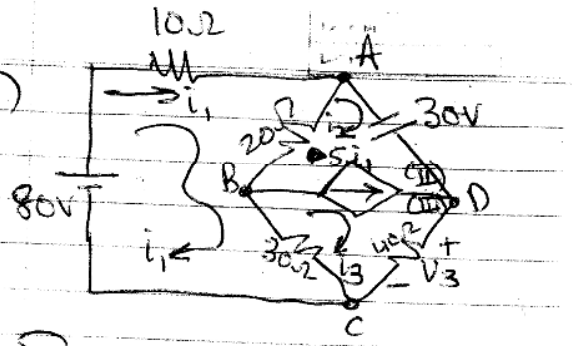
$1.5i_4 = -30i_1 + 0i_2 + 70i_3$

$\therefore -31.5i_1 + 0i_2 + 70i_3 = 0$ ——(III)

$\therefore i_1 = 3.929$
$i_2 = 5.134$
$i_3 = 1.768$

$V_3 = 40 i_3 = 70.72V$

e)



By KVL to loop I:-

$$80 = 60i_1 - 20i_2 - 30i_3 \quad \text{——(I)}$$

Loop's II and (III) form supermesh

{Since a current source is between the two loop}

Equation of supermesh is

$$i_3 - i_2 = 0.5i_1$$

$$\therefore 0.5i_1 + i_2 - i_3 = 0 \quad \text{——(II)}$$

By KVL to outer loop A-B-C-D-A :-

$$30 = -50i_1 + 20i_2 + 70i_3 \quad \text{——(III)}$$

$i_1 = 1.261$

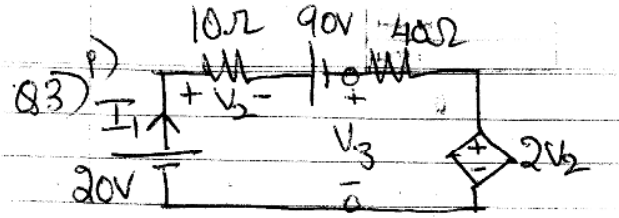
$i_2 = -3.87$

$i_3 = 2.435$

$V_3 = 40i_3$

$= 97.4V$

Q3) i)



$V_2 = 10I_1$ —— (I)

By KVL

$20 - 90 - 2V_2 = 50I_1$

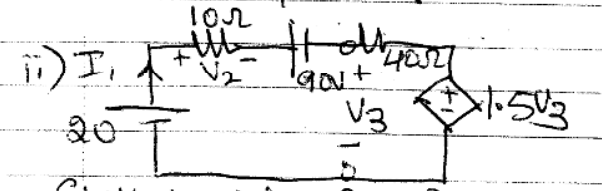
$-70 = 2V_2 + 50I_1$

From (I)

$-70 = 20I_1 + 50I_1$

$\therefore I_1 = -1A$

ii)



{KVL to right of V_3}

$V_3 - 1.5V_3 = 40I_1$

$-0.5V_3 = 40I_1$

$\therefore V_3 = -80I_1$ —— (I)

By KVL,

$20 - 90 - 1.5V_3 = 50I_1$

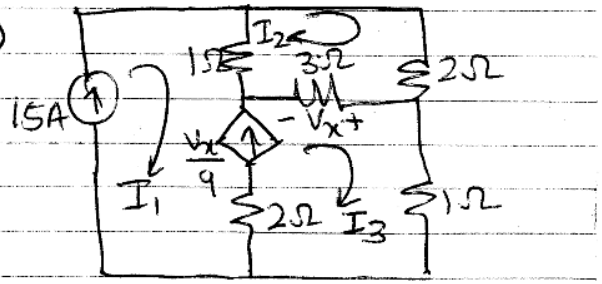
$-70 = 1.5V_3 + 50I_1$

From (I)

$-70 = 1.5(-80I_1) + 50I_1$

$\therefore I_1 = 1A$

Q4)



$I_1 = 15A$ —— (I)

By KVL to loop II:-

$-I_1 + 6I_2 - 3I_3 = 0$

From (I)

$-15 + 6I_2 - 3I_3 = 0$

$0V_x + 6I_2 - 3I_3 = 15$ — (II)

Eq. of supermesh is,

$I_3 - I_1 = \frac{V_x}{9}$

$\therefore I_3 - 15 = \frac{V_x}{9}$ {from (I)}

$\therefore V_x - 9I_3 = -135$

$V_x + 0I_2 - 9I_3 = -135$ — (III)

Also, $V_x = 3(-I_2 + I_3)$

$\therefore V_x + 3I_2 - 3I_3 = 0$ — (IV)

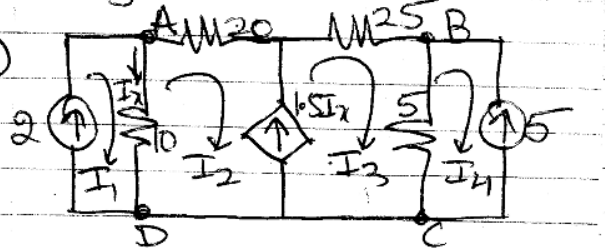
From (II), (III), (IV)

$V_x = 18$

$I_2 = 11$

$I_3 = 17$

Q5)



$I_1 = 2$ — (I) ; $I_x = I_1 - I_2$ — (III)

$I_4 = -5$ — (II)

Eq. of supermesh is

$I_3 - I_2 = 1.5I_x$

From (III)

$I_3 - I_2 = 1.5(I_1 - I_2)$

from (I)

$I_3 - I_2 = 1.5(2 - I_2)$

$0.5I_2 + I_3 = 3$ — (IV)

By KVL to A-B-C-D-A:-

$-10I_1 + 30I_2 + 30I_3 - 5I_4 = 0$

from (I) & (II)

$-20 + 30I_2 + 30I_3 + 25 = 0$

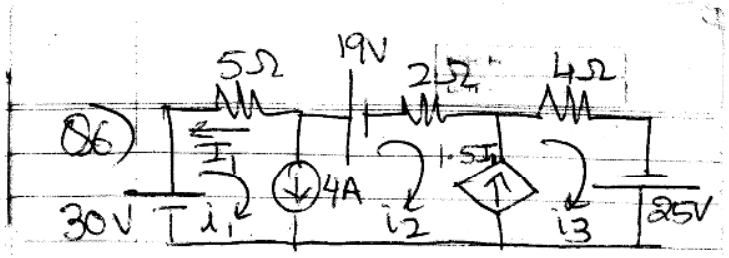
$\therefore 30I_2 + 30I_3 = -5$ — (V)

from (IV) & (V)

$I_2 = -6.333$.

$I_3 = +6.167$

From (III) $I_x = 2 + 6.333 = 8.333A$



$i_1 = -I_1$ — (I)

Eq. of supermesh-1

$i_1 - i_2 = 4$

$i_1 - i_2 + 0i_3 = 4$ — (II)

Eq. of supermesh-2

$i_3 - i_2 = 1.5I_1$

from (I)

$i_3 - i_2 = -1.5i_1$

$\therefore 1.5i_1 - i_2 + i_3 = 0$ — (III)

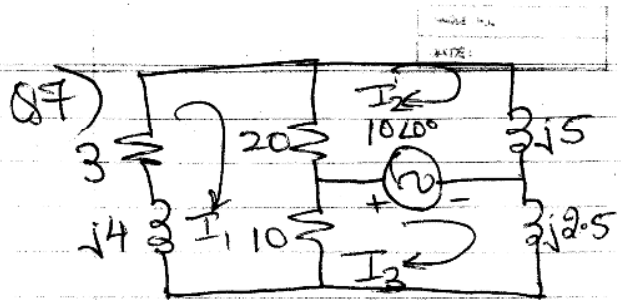
By KVL to outer loop:-

$30 - 19 + 25 = 5i_1 + 2i_2 + 4i_3$

$\therefore 5i_1 + 2i_2 + 4i_3 = 36$ — (IV)

$\therefore i_1 = 12; i_2 = 8; i_3 = -10 \therefore I_1 = -1$

Q7)



By KVL to loop I :-

$(33+j4)I_1 - 20I_2 - 10I_3 = 0$ —(I)

By KVL to loop II :-

$-20I_1 + (20+j5)I_2 = 10$

$\therefore I_2 = \frac{20I_1}{20+j5}$ —(II)

By KVL to loop III :-

$-10I_1 + (10+j2.5)I_3 = -10$

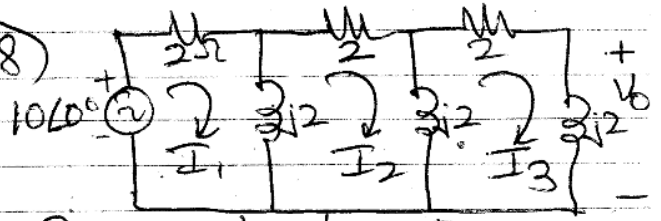
$\therefore I_3 = \frac{10I_1}{10+j2.5}$ —(III)

Subs. (II) & (III) in (I)

$I_1\left[(33+j4)(1) - \frac{20(20)}{(20+j5)} - \frac{10(10)}{(10+j2.5)}\right] = 0$

$\therefore I_1 = 0\ A.$

Q8)



By KVL to loop I :-

$(2+j2)I_1 - j2I_2 = 10$

$\therefore I_1 = \frac{10+j2)I_2}{2+j2}$ —(I)

By KVL to loop II :-

$-j2I_1 + (2+j4)I_2 - j2I_3 = 0$ —(II)

By KVL to loop III :-

$-j2I_2 + (2+j4)I_3 = 0$

$\therefore I_2 = \left(\frac{2+j4}{j2}\right) I_3$ — (III)

Subs. in (I)

$\therefore I_1 = 10 + (j2)\left(\frac{2+j4}{j2}\right) I_3$

$\frac{}{2+j2}$

$I_1 = \frac{10 + (2+j4)I_3}{2+j2}$ — (IV)

Subs. (III) & (IV) in (II)

$\therefore -j2\left[\frac{10+(2+j4)I_3}{2+j2}\right] + (2+j4)\left(\frac{2+j4}{j2}\right) I_3 - j2I_3 = 0$

$\therefore I_3\left[\frac{(-j2)(2+j4)}{(2+j2)} + \frac{(2+j4)^2}{j2} - j2\right] = \frac{j20}{2+j2}$

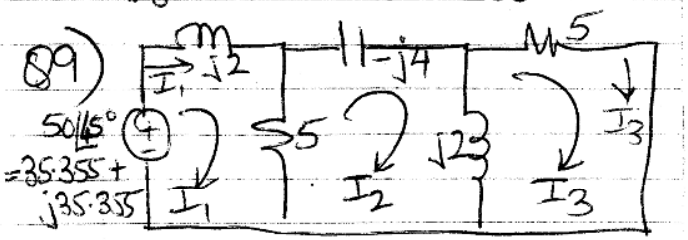
~~$I_3 = 0.7353 + 0.4412i$~~

$I_3 = 0.6098 + 0.4878i$

$V_o = j2(I_3) = -0.9756 + 1.2195i$

$V_o = 1.5617 \angle 128.66°$

89)



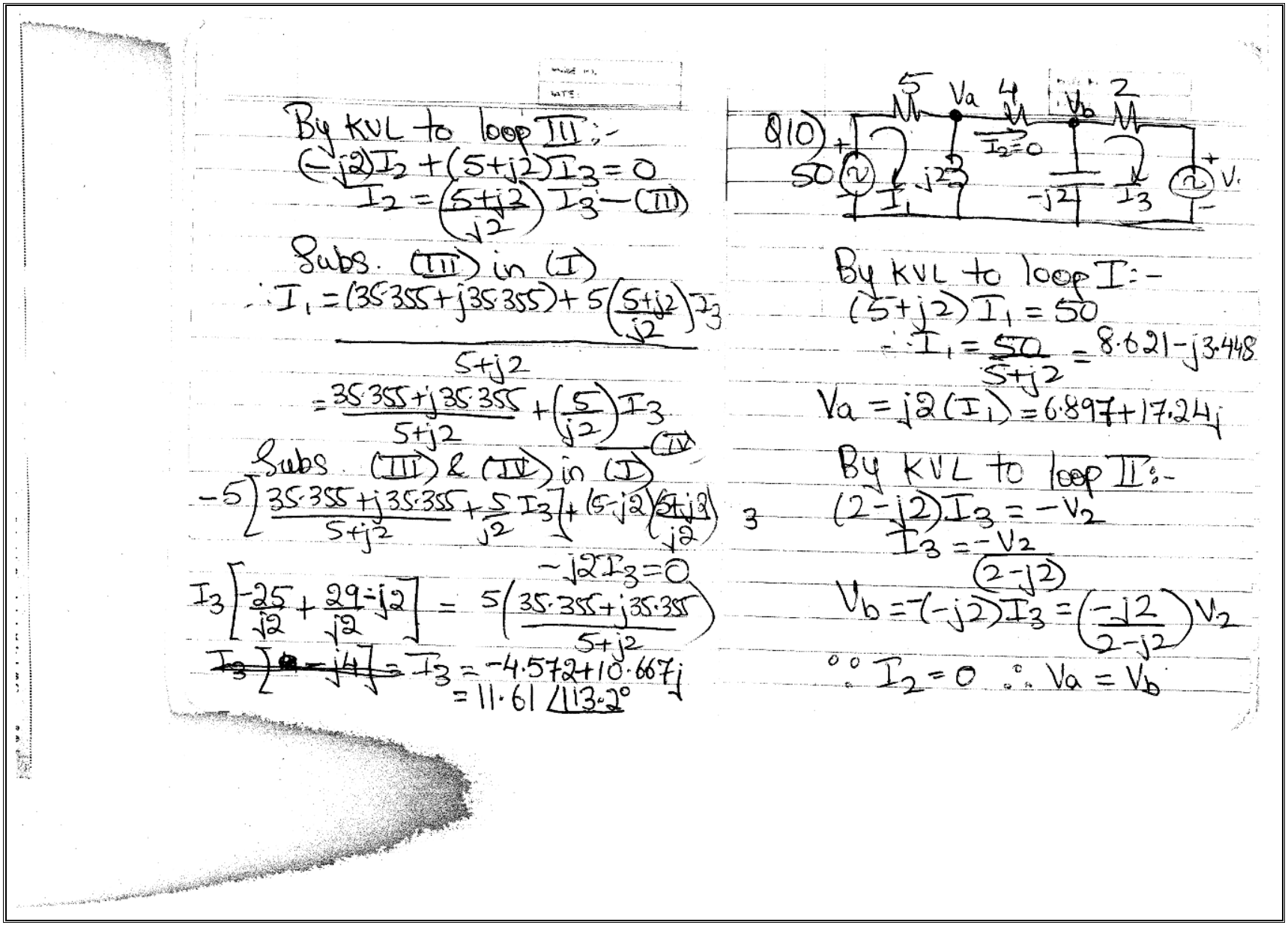
By KVL to loop I:-

$(5+j2)I_1 - 5I_2 = 35.355 + j35.355$

$I_1 = \frac{(35.355 + j35.355) + 5I_2}{5+j2}$ — (I)

By KVL to loop II:-

$-5I_1 + (5-j2)I_2 - j2I_3 = 0$ — (II)



Q10)

By KVL to loop I:-

$(5+j2)I_1 = 50$

$\therefore I_1 = \frac{50}{5+j2} = 8.621 - j3.448$

$V_a = j2(I_1) = 6.897 + 17.24j$

By KVL to loop II:-

$(2-j2)I_3 = -V_2$

$I_3 = \frac{-V_2}{(2-j2)}$

$V_b = -(-j2)I_3 = \left(\frac{-j2}{2-j2}\right)V_2$

$\because I_2 = 0 \quad \therefore V_a = V_b$

By KVL to loop III:-

$(-j2)I_2 + (5+j2)I_3 = 0$

$I_2 = \left(\frac{5+j2}{j2}\right)I_3 \quad -(III)$

Subs. (III) in (I)

$\therefore I_1 = (35.355 + j35.355) + 5\left(\frac{5+j2}{j2}\right)I_3$

$\frac{5+j2}{5+j2}$

$= \frac{35.355 + j35.355}{5+j2} + \left(\frac{5}{j2}\right)I_3 \quad -(IV)$

Subs (III) & (IV) in (I)

$-5\left[\frac{35.355 + j35.355}{5+j2} + \frac{5}{j2}I_3\right] + (5-j2)\left(\frac{5+j2}{j2}\right)I_3 - j2I_3 = 0$

$I_3\left[\frac{-25}{j2} + \frac{29-j2}{j2}\right] = 5\left(\frac{35.355 + j35.355}{5+j2}\right)$

$I_3[-j4] = I_3 = -4.572 + 10.667j$

$= 11.61 \angle 113.2°$

$\therefore 6.897 + j17.24 = -j2\ V_2$

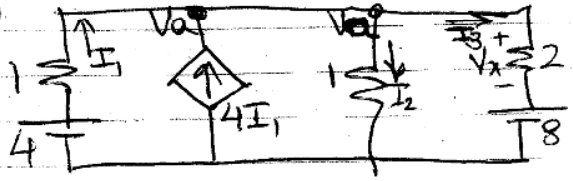
$(2-j2)$

$\therefore V_2 = -10.345 + j24.138$

$V_2 = 26.26 \angle 113.2°\ V$

TYPE II : NODAL ANALYSIS

Q11)



By KCL,

$I_1 + 4I_1 = I_2 + I_3$

$5I_1 = I_2 + I_3$

$5\left(\frac{4 - Va}{1}\right) = \frac{Va}{1} + \frac{Va - 8}{2}$

$20 - 5Va = Va + 0.5Va - 4$

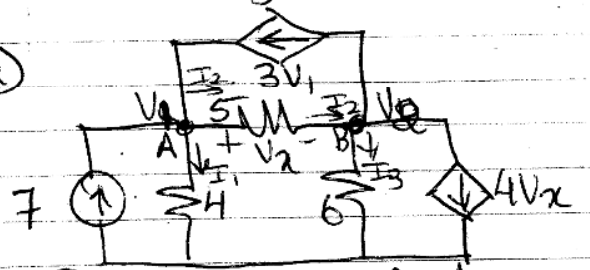
$6.5\,Va = 24$

$\therefore Va = 3.692$

$I_3 = \frac{Va - 8}{2} = -2.154$

$Vx = 2I_3 = -4.308\ V$

Q12)



By KCL at node A :-

$7 + 3V_1 = I_1 + I_2$

$7 + 3V_1 = \frac{V_1}{4} + \left(\frac{V_1 - V_2}{5}\right)$

$\left(\frac{1}{4} + \frac{1}{5} - 3\right)V_1 - \frac{1}{5}V_2 = 7$ —— (I

$V_1 - V_x - V_2 = 0$

$\therefore V_x = V_1 - V_2$

By KVL at node B:-

$I_2 = I_3 + 4V_x + 3V_1$

$\left(\frac{V_1 - V_2}{5}\right) = \frac{V_2}{6} + 4(V_1 - V_2) + 3V_1$

$\left(4 + 3 - \frac{1}{5}\right)V_1 = \left(4 - \frac{1}{5} - \frac{1}{6}\right)V_2$

$\frac{34}{5}V_1 = \left(\frac{109}{30}\right)V_2$

$\therefore V_2 =$ ~~1.87 V_1 (II)~~

Subs. (II) in (I),

$-2.55 V_1 - \frac{V_2}{5} = 7$

$-2.55 V_1 - \frac{1.87}{5} V_1 = 7$

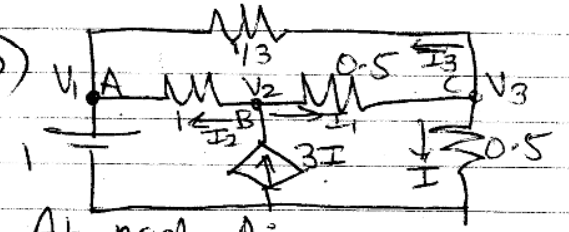
$V_1 = -2.394\ V$

$V_2 = 4.477\ V$ {from (II)}

$V_x = V_1 - V_2$

$= 2.083\ V$

(13)



At node A:-

$V_1 = 1\ V$ —— (I)

By KCL at node B:-

$3I = I_1 + I_2$

$3I = \frac{V_2 - V_3}{0.5} + \frac{V_2 - V_1}{1}$

Subs. $I = \frac{V_3}{0.5}$

$\therefore \frac{3V_3}{0.5} = \frac{V_2 - V_3}{0.5} + V_2 - 1$

$V_2\left(\frac{1}{0.5}+1\right) + \left(\frac{-1}{0.5} - \frac{3}{0.5}\right)V_3 = 1$

$3V_2 - 8V_3 = 1$ —— (II)

By KCL at node C:-

$I_1 = I + I_3$

$\frac{V_2 - V_3}{0.5} = \frac{V_3}{0.5} + \left(\frac{V_3 - V_1}{1/3}\right)$

~~From~~ from (I)

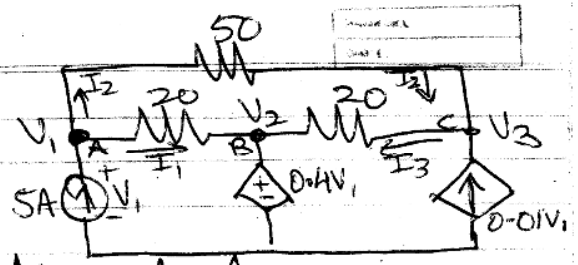
$2V_2 - 2V_3 = 2V_3 + 3V_3 - 3$ (I)

$2V_2 - 7V_3 = -3$ — (III)

from (II) & (III)

$\therefore V_2 = 6.2V$; $V_3 = 2.2V$

Q14)



KCL At node A:-

$5 = I_1 + I_2$

$5 = \left(\frac{V_1 - V_2}{20}\right) + \left(\frac{V_1 - V_3}{50}\right)$

$\left(\frac{1}{20} + \frac{1}{50}\right)V_1 - \frac{1}{20}V_2 - \frac{1}{50}V_3 = 5$

$0.07V_1 - 0.05V_2 - 0.02V_3 = 5$

$7V_1 - 5V_2 - 2V_3 = 500$ — (I)

At node B:-

$V_2 = 0.4V_1$

$\therefore 0.4V_1 - V_2 + 0V_3 = 0$ — (II)

By KCL at node C :-

$$I_2 + 0.01V_1 = I_3$$

$$\frac{V_1 - V_3}{50} + 0.01V_1 = \frac{V_3 - V_2}{20}$$

$$\left(0.01 + \frac{1}{50}\right)V_1 + \frac{1}{20}V_2 + \left(\frac{-1}{50} - \frac{1}{20}\right)V_3 = 0$$

$$0.03V_1 + 0.05V_2 - 0.07V_3 = 0$$

$$\therefore 3V_1 + 5V_2 - 7V_3 = 0 \quad \text{—(III)}$$

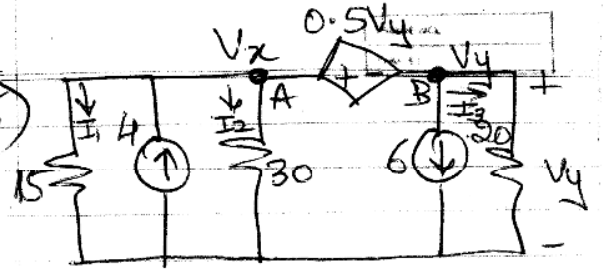
From (I), (II) & (III)

$V_1 = 140\ V$

$V_2 = 58\ V$

$V_3 = 100\ V$

Q15)



{ Nodes A & B are supernodes as there is a volt. source bet. them without any resist.

Eqn of supernode is

$$V_x - 0.5V_y - V_y = 0$$

$$V_x = 1.5V_y \quad \text{—(I)}$$

KCL at nodes A & B :-

$$I_1 + I_2 + 6 + I_3 = 4$$

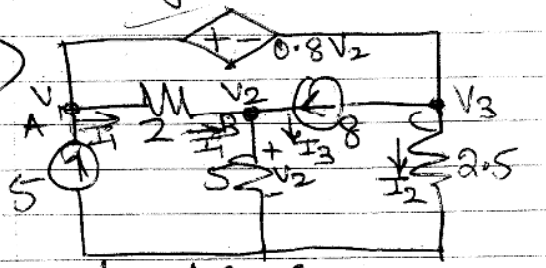
$$\frac{V_x}{15} + \frac{V_x}{30} + 2 + \frac{V_y}{20} = 0$$

From (I)

$$\frac{1.5V_y}{15} + \frac{1.5V_y}{30} + \frac{V_y}{20} = -2$$

$$\therefore V_y = -10\,V$$

Q16)



Nodes A & C are supernode

Eq. of supernode is

$$V_1 - 0.8V_2 - V_3 = 0 \quad \text{— (I)}$$

KCL at A & C:-

$$5 = I_1 + 8 + I_2$$

$$5 = \left(\frac{V_1 - V_2}{2}\right) + 8 + \left(\frac{V_3}{2.5}\right)$$

$$\frac{1}{2}V_1 - \frac{1}{2}V_2 + \frac{1}{2.5}V_3 = -3$$

$$0.5V_1 - 0.5V_2 + 0.4V_3 = -3 \quad \text{(II)}$$

KCL at node B:-

$$I_1 + 8 = I_3$$

$$\left(\frac{V_1 - V_2}{2}\right) + 8 = \frac{V_2}{5}$$

$$\frac{1}{2}V_1 + \left(-\frac{1}{2} - \frac{1}{5}\right)V_2 = -8$$

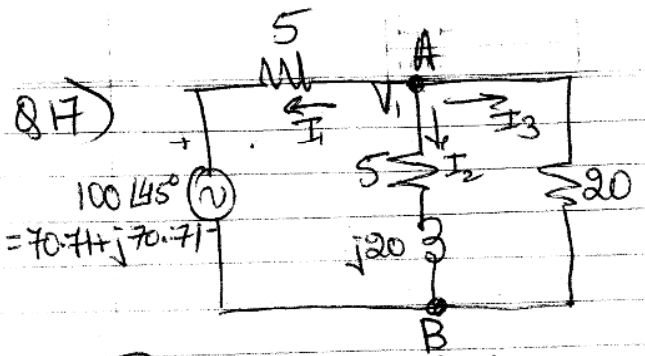
$$0.5V_1 - 0.7V_2 = -8 \quad \text{— (III)}$$

$$V_1 = 20.27\ V$$

$$V_2 = 25.91\ V$$

$$V_3 = -0.455\ V$$

Q17)



By KCL at node A:-

$$I_1 + I_2 + I_3 = 0$$

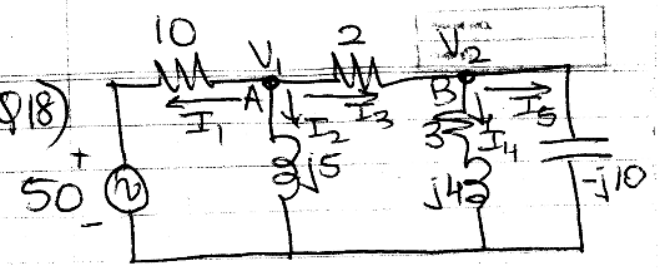
$$\frac{V_1 - 70.71 - j70.71}{5} + \frac{V_1}{5+j20} + \frac{V_1}{20} = 0$$

$$V_1\left(\frac{1}{5} + \frac{1}{5+j20} + \frac{1}{20}\right) = \frac{70.71 + j70.71}{5}$$

$$V = 42.93 + j61.74$$

$$= 75.2\angle 55.19°$$

Q18)



By KCL at node A:-

$$I_1 + I_2 + I_3 = 0$$

$$\frac{V_1 - 50}{10} + \frac{V_1}{j5} + \frac{V_1 - V_2}{2} = 0$$

$$V_1\left(\frac{1}{10} + \frac{1}{j5} + \frac{1}{2}\right) - \frac{V_2}{2} = 5 \quad \text{—(I)}$$

By KCL at node B:-

$$I_3 = I_4 + I_5$$

$$\frac{V_1 - V_2}{2} = \frac{V_2}{3+j4} + \frac{V_2}{-j10}$$

$$V_1\left(\frac{1}{2}\right) = V_2\left(\frac{1}{2} + \frac{1}{3+j4} - \frac{1}{j10}\right)$$

$V_1 = (1.24 - j0.12)V_2$ — (II)

Subs. in (I)

$V_2[(1.24 - j0.12)(0.6 - 0.2i)] - 0.5V_2 = 5$

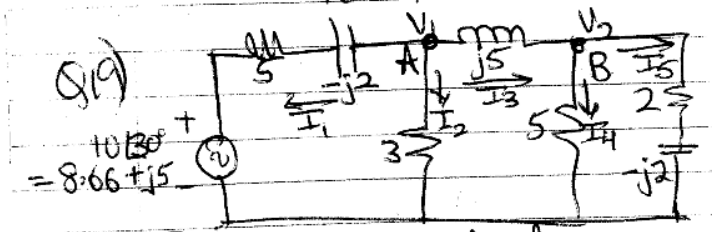
$V_2 = 7.29 + j10.61$

$= 12.88 \angle 55.49°$

From (II) $V_1 = 10.32 + j12.28$

$= 16.04 \angle 49.96°$

Q.19)



By KCL at node A:-

$I_1 + I_2 + I_3 = 0$

$\frac{V_1 - 8.66 - j5}{5 - j2} + \frac{V_1}{3} + \frac{V_1 - V_2}{j5} = 0$

$V_1\left(\frac{1}{5-j2} + \frac{1}{3} + \frac{1}{j5}\right) - \frac{V_2}{j5} = \frac{8.66 + j5}{5 - j2}$

$V_1(0.506 - 0.131j) + 0.2jV_2 = 11.48 + j1.46$ — (I)

By KCL at node B

$I_3 = I_4 + I_5$

$\frac{V_1 - V_2}{j5} = \frac{V_2}{5} + \frac{V_2}{2 - j2}$

$V_1\left(\frac{1}{j5}\right) = V_2\left(\frac{1}{j5} + \frac{1}{5} + \frac{1}{2-j2}\right)$

$V_1 = (-0.25 + j2.25)V_2$ — (I)

Subs. in (I)

$V_2 = 1.15 - j0.7$

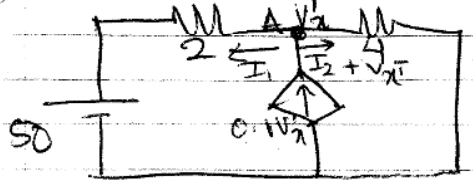
$V_1 = 1.29 + j2.76$

$I_1 = \frac{V_1 - 8.66 - j5}{5 - j2} = -1.12 - j0.9$

∴ Current from $10\angle 30°$ $= -I = 1.44 \angle 38.8$

TYPE III : SUPERPOSITION THE

Q20) Consider 50V & short 100V



By KCL at node A:-

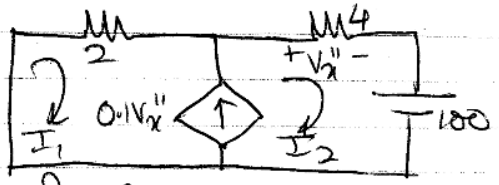
$$I_1 + I_2 = 0.1V_x'$$

$$\frac{V_x' - 50}{2} + \frac{V_x'}{4} = 0.1V_x'$$

$$V_x'\left(\frac{1}{2} + \frac{1}{4} - 0.1\right) = 25$$

$$V_x' = 38.46\ V$$

Consider 100V & short 50V



Eq. of supermesh:-

$$I_2 - I_1 = 0.1V_x''$$

$$-I_1 + I_2 - 0.1V_x'' = 0 \quad \text{— (I)}$$

Also,

$$V_x'' = 4I_2$$

$$0I_1 + 4I_2 - V_x'' = 0 \quad \text{— (II)}$$

By KVL to outer loop-

$$-100 = 2I_1 + 4I_2$$

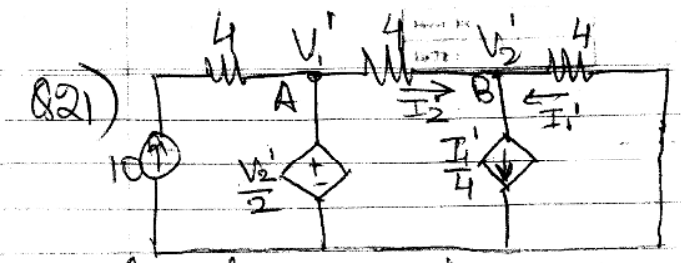
$$2I_1 + 4I_2 + 0V_x'' = 100 \quad \text{— (III)}$$

$$V_x'' = -76.93$$

$$V_x = V_x' + V_x''$$

$$= -38.46\ V$$

Q21)



Consider 10A & short 20V

At node A:-

$V_1' = \frac{V_2'}{2} \quad \therefore V_2' = 2V_1' \quad \text{—(I)}$

KCL at node B:-

$I_2' + I_1' = \frac{I_1'}{4}$

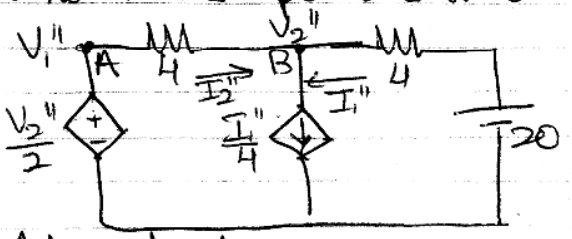
$\frac{V_1' - V_2'}{4} = -\frac{3}{4}\left(-\frac{V_2'}{4}\right)$

$\frac{V_1'}{4} = \frac{V_2'}{4} + \frac{3V_2'}{16}$

$V_1' = 1.75V_2' \quad \text{—(II)}$

From (I) & (II) $V_1' = 0; V_2' = 0$

When 10A is open & cons. 20V



At node A:-

$V_1'' = \frac{V_2''}{2} \quad \therefore V_2'' = 2V_1'' \quad \text{—(I)}$

KCL at node B

$I_2'' + I_1'' = \frac{I_1''}{4}$

$\frac{V_1'' - V_2''}{4} = -\frac{3}{4}\left(\frac{20 - V_2''}{4}\right)$

$\frac{V_1''}{4} = \frac{-15}{4} + \left(\frac{1}{4} + \frac{3}{16}\right)V_2''$

$V_1'' = -15 + 1.75V_2'' \quad \text{—(II)}$

From (I) & (II)

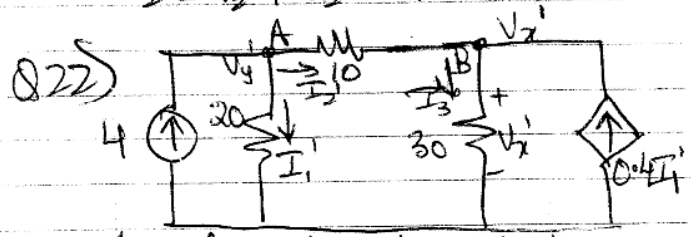
$V_1'' = 6V$

$V_2'' = 12V$

$V_1 = V_1' + V_1'' = 6V$

$V_2 = V_2' + V_2'' = 12V$

Q22)



Consider 4A & short 60V

KCL at node A

$4 = I_1' + I_2'$

$4 = \frac{V_y'}{20} + \frac{V_y' - V_x'}{10}$

$V_x' = V_y'\left(\frac{1}{2} + 1\right) - 40$

$V_x' = 1.5V_y' - 40$ — (I)

KCL at node B:-

$I_2' + 0.4I_1' = I_3'$

$\frac{V_y' - V_x'}{10} + 0.4\left(\frac{V_y'}{20}\right) = \frac{V_x'}{30}$

$V_y'\left(\frac{1}{10} + \frac{1}{50}\right) = V_x'\left(\frac{1}{30} + \frac{1}{10}\right)$

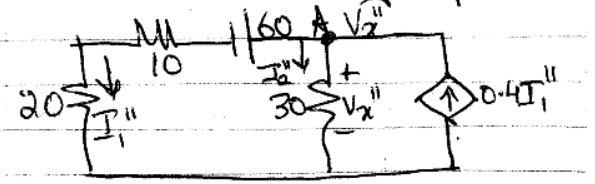
$0.12V_y' = 0.133V_x'$

$V_y' = 1.11V_x'$ — (II)

From (I) & (II)

$V_x' = 60 \text{ V}$

Consider 60V Battery & open 4A



KCL at node A :-

$0.4I_1'' = I_1'' + I_2''$

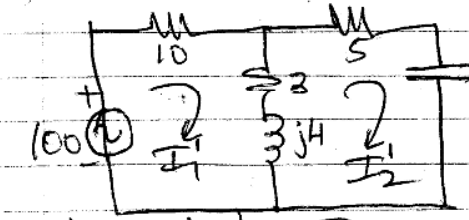
$-0.6\left(\frac{V_x''-60}{30}\right) = \frac{V_x''}{30}$

$\frac{0.6\times60}{30} = V_x''\left(\frac{1}{30}+\frac{0.6}{30}\right)$

$V_x'' = 22.5\ V$

$V_x = V_x' + V_x'' = 82.5\ V$

Q23) Consider 100 V short $50\angle30°$ V



KVL to loop I :-

$100 = (10+3+j4)I_1' - (3+j4)I_2'$

$100 = (13+j4)I_1' - (3+j4)I_2'$ —(I)

By KVL to loop II :-

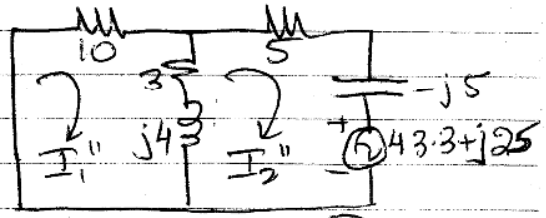
$-(3+j4)I_1' + (8-j)I_2' = 0$

$I_2' = (+0.308+0.54j)$ —(II)'

from (I) & (II)

$I_1' = 6.981 - j0.566$

Consider $50\angle30°$ & short 100V



By KVL to loop I :-

$(13+j4)I_1'' - (3+j4)I_2'' = 0$

$I_2'' = (2.2 - j1.6) I_1'' \quad -(I)$

By KVL to loop II :-

$-(3+j4)I_1'' + (8-j)I_2'' = -43.3+j25$

$\quad -(II)$

from (I) & (II)

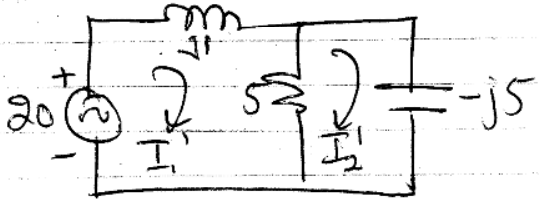
$I_1'' = -0.166 - j2.166$

$I_1 = I_1' + I_1''$

$= 6.815 - j2.732$

$= 7.34 \angle -21.845°$

Q24) Consider 20V & Short 10V



KVL to loop I :-

$(5+j)I_1' - 5I_2' = 20 \quad -(I)$

KVL to loop II

$-5I_1' + (5-j5)I_2' = 0$

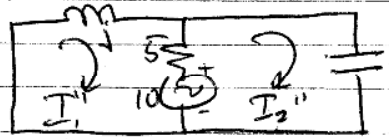
$I_1' = (1-j)I_2' \quad -(II)$

Subs. (II) in (I)

$(5+j)(1-j)I_2' - 5I_2' = 20$

$I_2 = 1.176 + j4.706$

Consider 10V & short 20V



KVL to loop I :-

$(5+j)I_1'' - 5I_2'' = -10$

$\quad -(I)$

KVL to loop II :-

$-5I_1'' + (5-j5)I_2'' = 10$ —(II)

$\Delta = \begin{vmatrix} 5+j & -5 \\ -5 & 5-j5 \end{vmatrix} = 5 - j20$

~~$\Delta_2 = \begin{vmatrix} 5+j & 10 \\ -5 & 5-j5 \end{vmatrix}$~~

$\Delta_2 = \begin{vmatrix} 5+j & -10 \\ -5 & 10 \end{vmatrix} = 10j$

$I_2'' = \frac{\Delta_2}{\Delta} = -0.471 + j0.118$

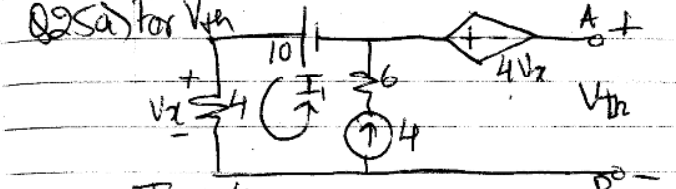
$I_2 = I_2' + I_2''$

$= 0.705 + j4.824$

$= 4.875 \angle 81.69°$

TYPE IV ; THEVENIN'S & NORTON'S THE

Q25a) for V_{th}



$I_1 = 4$

$V_x = 4I_1 = 4(4) = 16\ V$

By KVL to outer loop :-

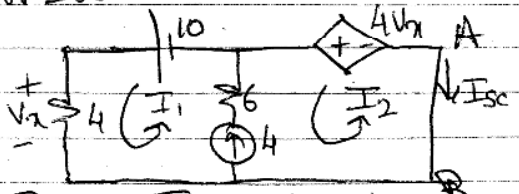
$V_{th} + 4V_x + 10 = 4I_1$

$V_{th} + 4(16) + 10 = 4(4)$

$V_{th} + 64 + 10 = 16$

$V_{th} = -58V$

for I_{sc}



$I_{sc} = -I_2$; $V_x = 4I_1$

$I_1 - I_2 = 4$ —(I)

By KVL to outer loop:-

$4V_x + 10 = 4I_1$

$4(4I_1) + 10 = 4I_1$

$I_1 = -0.833A$

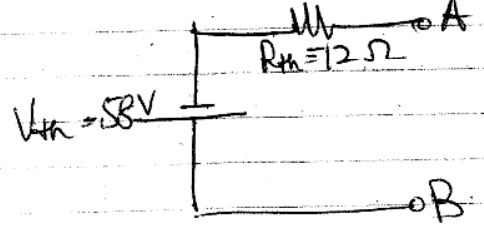
Subs. in (I)

$\therefore I_2 = -4.833A$

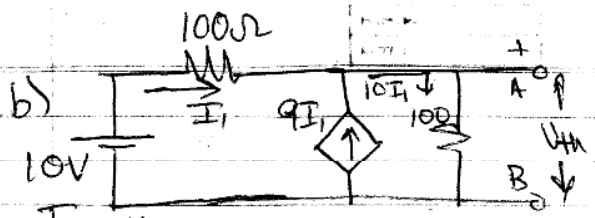
$I_{sc} = 4.833A$

$R_{th} = \frac{V_{th}}{I_{sc}} = 12\Omega$

Thevenins Eq. ckt. is



(b)



For V_{th}:-

$V_{th} = (10I_1)(100)$

$= 1000I_1$

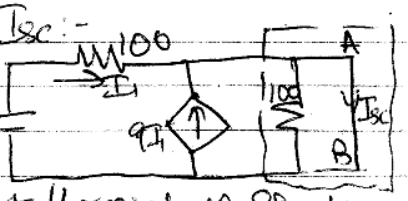
By KVL to outer loop:-

$100I_1 + 1000I_1 = 10$

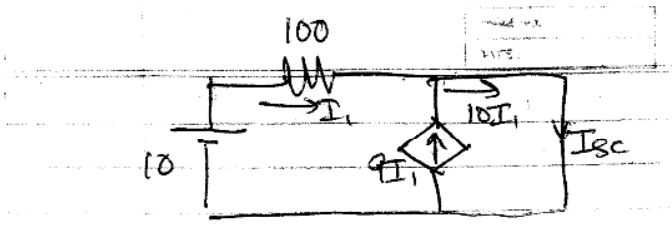
$\therefore I_1 = 0.00909A$

$V_{th} = 9.09V$

For I_{sc}:-



Short // resist. ≅ Short



$I_{sc} = 10I_1$

By KVL to outer loop:-

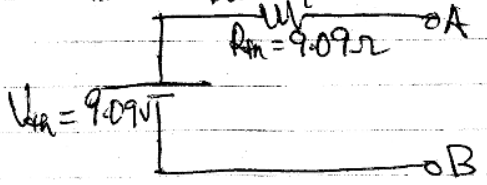
$100I_1 = 10$

$\therefore I_1 = 0.1A$

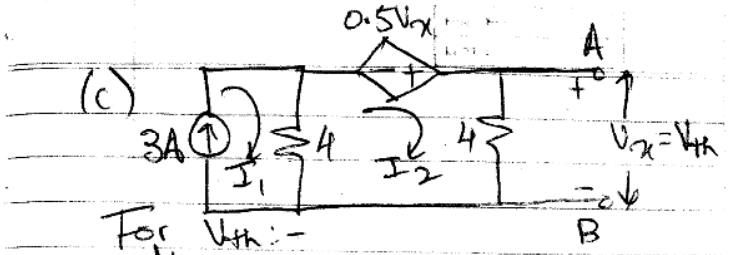
$\therefore I_{sc} = 1A$

$R_{th} = \frac{V_{th}}{I_{sc}} = 9.09\Omega$

Thevenin's Eq. ckt. is



(c)



For V_{th}:-

$V_{th} = V_x$

$V_x = 4I_2$ —— (I)

$I_1 = 3A$ —— (II)

By KVL to loop II:-

$-4I_1 + 8I_2 = 0.5V_x$

$-4(3) + 8I_2 = 0.5(4I_2)$

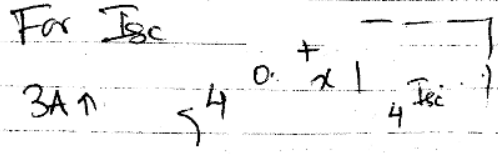
$\therefore I_2 = 2A$

from (I)

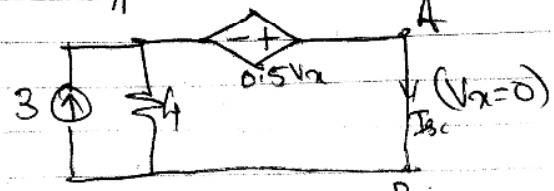
$V_x = 4I_2 = 8V$

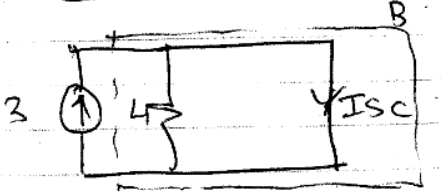
$V_{th} = V_x = 8V$

For I_{sc}

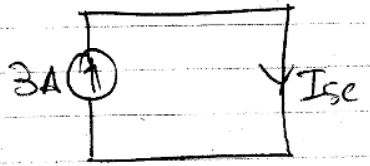


Short // Resist. ⇒ Short





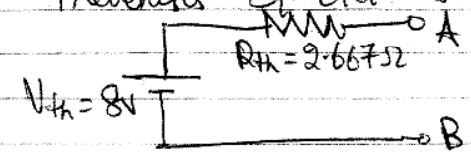
Short // Resist. ⇒ Short



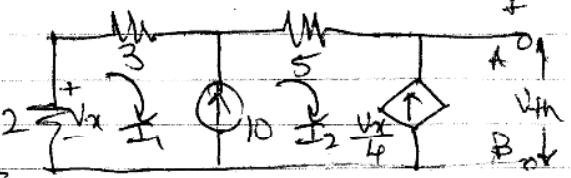
$I_{sc} = 3A$

$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{8}{3} = 2.667\Omega$

Thevenins Eq. ckt



(a)



For V_{th} :-

$I_2 = -\frac{V_x}{4}$ — (I)

$V_x = -2I_1$ — (II)

From (I) & (II)

$I_1 = 2I_2$ — (III)

Eq. of supermesh :-

$I_2 - I_1 = 10$ — (IV)

From (III) & (IV)

$I_1 = -20\,A$

$I_2 = -10\,A$

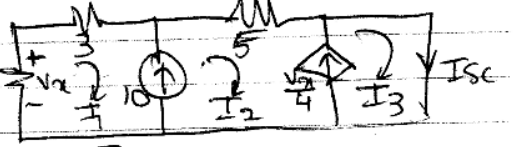
By KVL to outer loop

$5I_1 + 5I_2 = -V_{th}$

$\therefore 5(-20) + 5(-10) = -V_{th}$

$\therefore V_{th} = 150\,V$

For I_{sc} :-



$I_{sc} = I_3$

$V_x = -2I_1 \quad -(I)$

Eqns. of supermesh are :-

$I_2 - I_1 = 10 \quad -(II)$

$I_3 - I_2 = \frac{V_x}{4}$

from (I),

$I_3 - I_2 = -\frac{I_1}{2}$

$\therefore 0.5I_1 - I_2 + I_3 = 0 \quad -(III)$

By KVL to outer loop :-

$5I_1 + 5I_2 = 0$

$\therefore I_1 + I_2 + 0I_3 = 0 \quad -(IV)$

from (II), (III) & (IV)

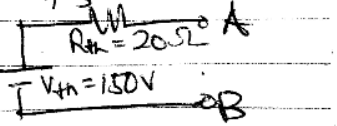
$\therefore I_1 = -5A$

$I_2 = 5A$

$I_{sc} = I_3 = 7.5A$

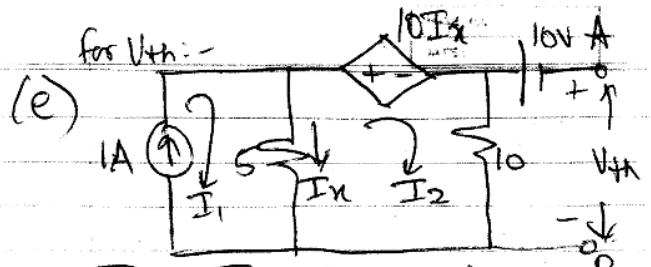
$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{150}{7.5} = 20\,\Omega$

$\therefore$ Thevenins Eqckt is



(e)

for V_{th} :-



$I_x = I_1 - I_2$ —(I)

$I_1 = 1A$

$\therefore I_x = 1 - I_2$ —(II)

By KVL to loop II :-

$-5I_1 + 15I_2 = -10I_x$

$-5I_1 + 15I_2 = -10(1 - I_2)$ $\{$from II$\}$

$-5I_1 + 5I_2 = -10$

$5I_1 - 5I_2 = 10$

$5(1) - 5I_2 = 10$

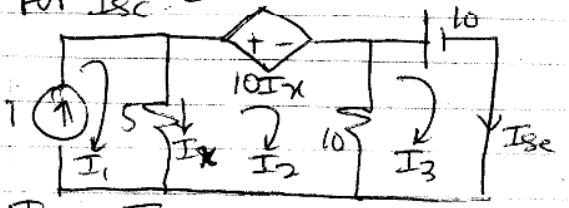
$I_2 = -1A$

By KVL to loop III :-

$V_{th} + 10 = 10I_2$

$\therefore V_{th} = -20V$

for I_{sc} :-



$I_{sc} = I_3$

$I_1 = 1$

$I_x = I_1 - I_2 = (1 - I_2)$

By KVL to loop II :-

$-10I_3 - 5I_1 + 15I_2 = -10I_x$

$-10I_3 - 5(1) + 15I_2 = -10(1 - I_2)$

$-10I_3 - 5 + 15I_2 = -10 + 10I_2$

$-10I_3 + 5I_2 = -5$ —(I)

~~$I_2 = -1A$~~

By KVL to loop III

$-10I_2 + 10I_3 = -10$

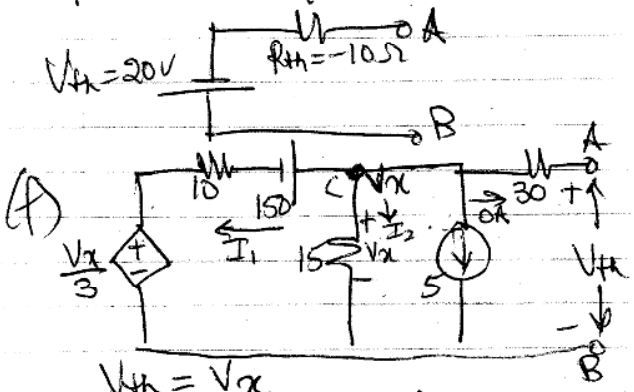
$I_2 = 3A$

$I_3 = 2A$

$I_{SC} = I_3 = 2A$

$R_{th} = \frac{V_{th}}{I_{SC}} = \frac{-20}{2} = -10\Omega$

Thevenin Eq. ckt ①



$V_{th} = V_x$

By KCL at node C

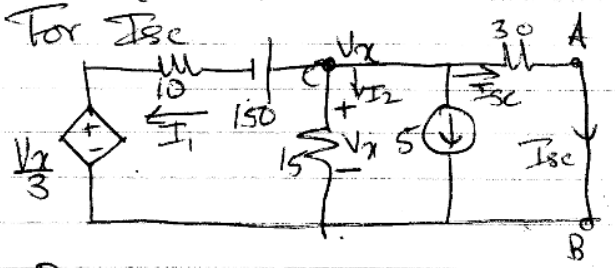
$I_1 + I_2 + 5 = 0$

$\frac{V_x - 150 - V_x/3}{10} + \frac{V_x}{15} + 5 = 0$

$V_x\left(\frac{1}{10} - \frac{1}{30} + \frac{1}{15}\right) = 15 - 5$

$\therefore V_x = V_{th} = 75V$

For I_{SC}



By KCL at node C

$I_1 + I_2 + 5 + I_{SC} = 0$

$\left(\frac{V_x - 150 - V_x/3}{10}\right) + \frac{V_x}{15} + 5 + \frac{V_x}{30} = 0$

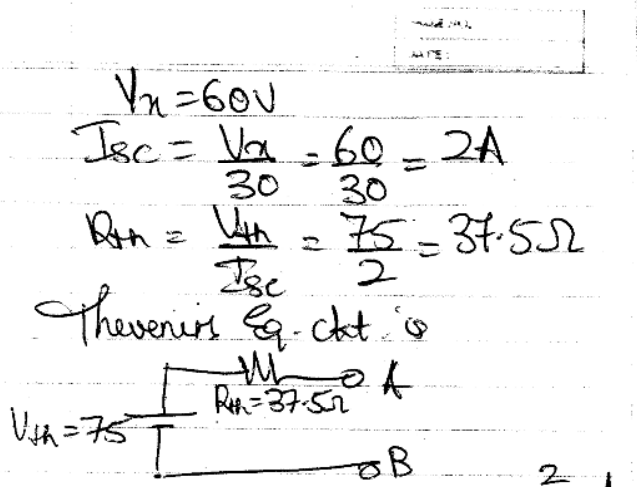
$V_x\left(\frac{1}{10} - \frac{1}{30} + \frac{1}{15} + \frac{1}{30}\right) = 15 - 5$

$V_x = 60V$

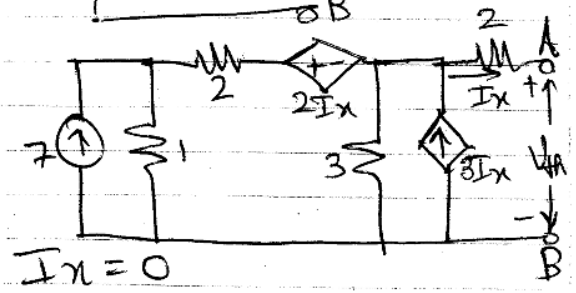
$I_{sc} = \frac{V_x}{30} = \frac{60}{30} = 2A$

$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{75}{2} = 37.5\Omega$

Thevenin's Eq. ckt is



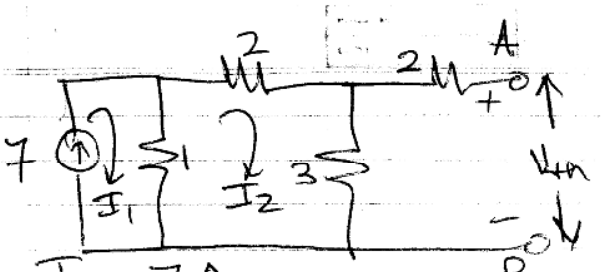
(9)



$I_x = 0$

$3I_x = 0$

$2I_x = 0$



$I_1 = 7A$

By KVL to loop I :-

$-I_1 + 6I_2 = 0$

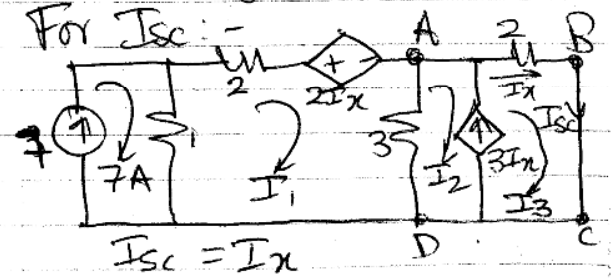
$I_2 = 1.167A$

By KVL to loop II :-

$V_{th} = 3I_2$

$= 3.5V$

For I_{sc} :-



$I_{sc} = I_x$

$I_3 = I_x = I_{sc}$

Eq. of supermesh,

$I_3 - I_2 = 3I_x$

$I_3 - I_2 = 3I_3$

$0I_1 + I_2 + 2I_3 = 0$ — (I)

By KVL to loop II :-

$-4(7) + 6I_1 - 3I_2 = -2I_x$

$6I_1 - 3I_2 + 2I_3 = 7$ — (II)

By KVL to A-B-C-D-A :-

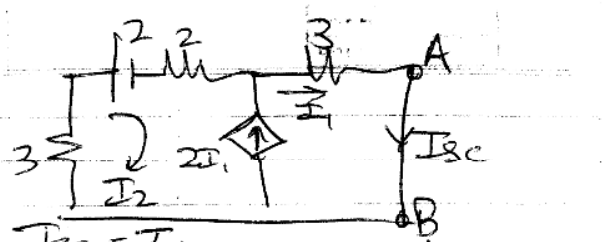
$-3I_1 + 3I_2 + 2I_3 = 0$ — (III)

$I_1 =$

$I_2 =$

$I_3 =$

(Q26)



$I_{sc} = I_1$

$I_1 - I_2 = 2I_1$ {Eq. of supermesh}

$\therefore I_1 + I_2 = 0$ —(I)

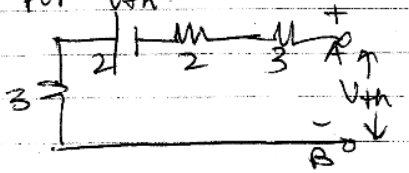
By KVL to outer loop :-

$-2 = 5I_2 + 3I_1$ —(II)

$\therefore I_1 = +1A = I_{sc}$

$I_2 = -1A$

For V_{th} :-



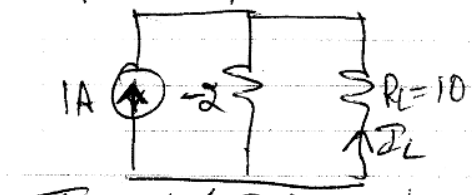
$I_1 = 0 \therefore 2I_1 = 0$

By KVL, $V_{th} + 2 = 8(0)$

$\therefore V_{th} = -2$

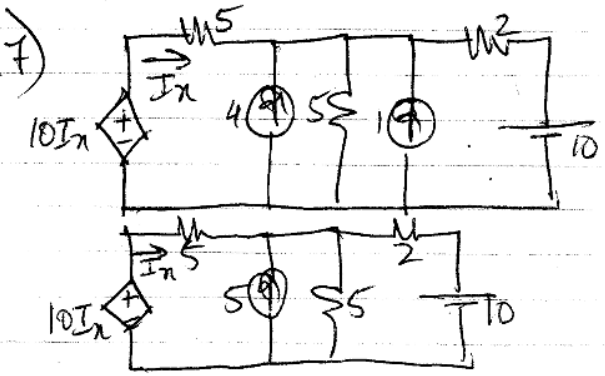
$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{-2}{+1} = -2$

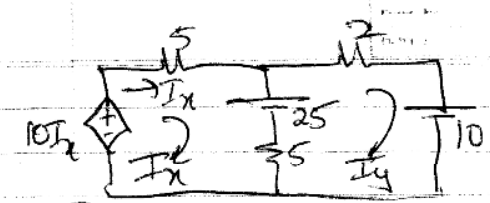
Norton's eq. ckt. is



$I_L = 1\left(\frac{-2}{8}\right) = \frac{-1}{4} = -0.25A$

Q27)





By KVL to loop I :-

$10I_x - 5I_y = 10I_x - 25$

$\therefore I_y = 5A$

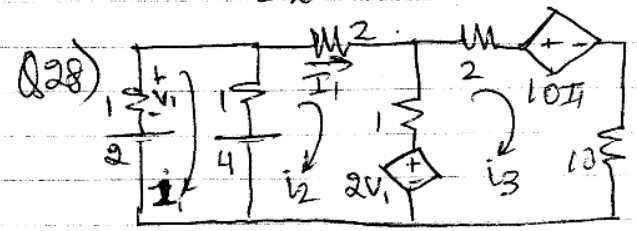
By KVL to loop II :-

$-5I_x + 7I_y = 15$

$\because I_y = 5$

$\therefore I_x = 4A$

Q28)



$i_2 = I_1$

$V_1 = -i_1$ — (I)

By KVL to loop I:-

$2i_1 - i_2 + 0i_3 = -2$ —(II)

By KVL to loop II:-

$-i_1 + 4i_2 - i_3 = 4 - 2V_1$

$-3i_1 + 4i_2 - i_3 = 4$ {from (I)}

—(III)

By KVL to loop III:-

$-i_2 + 13i_3 = 2V_1 - 10i_2$

$+2i_1 + 9i_2 + 13i_3 = 0$

—(IV)

$i_1 = -0.824$ A

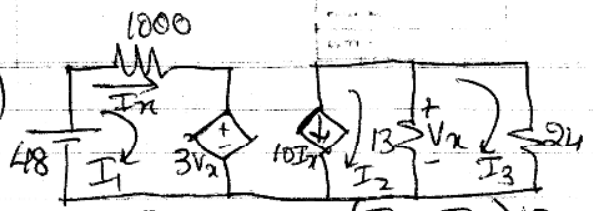
$i_2 = 0.353$ A

$i_3 = -0.118$ A

$P_{10\Omega} = i_3^2(R)$

$= 0.1396$

Q29)



$I_1 = I_x$; $V_x = (I_2 - I_3)13$

By KVL to loop I:-

$1000I_1 = 48 - 3V_x$

$1000I_1 = 48 - 3(I_2 - I_3)13$

$1000I_1 + 39I_2 - 39I_3 = 48$ —(I)

$I_2 = -10I_x$

$I_2 = -10I_1$

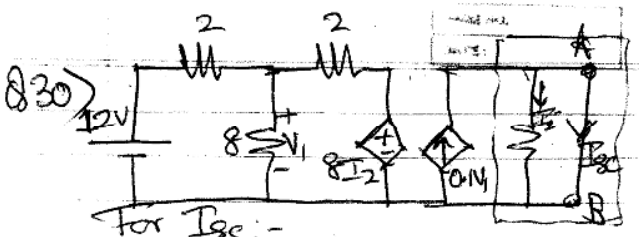
$\therefore 10I_1 + I_2 + 0I_3 = 0$ —(II)

By KVL to loop III:-

$0I_1 - 13I_2 + 37I_3 = 0$ —(III)

$I_1 = 0.0643$; $I_2 = -0.643$

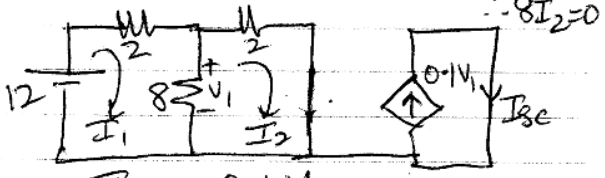
$I_3 = -0.226$A



For I_{sc} :-

Short // Resist. & Short & $I_2 = 0$

$\therefore 8I_2 = 0$



$I_{sc} = 0.1 V_1$

By KVL to loop I :-

$10I_1 - 8I_2 = 12$ —(I)

By KVL to loop II :-

$-8I_1 + 10I_2 = 0$

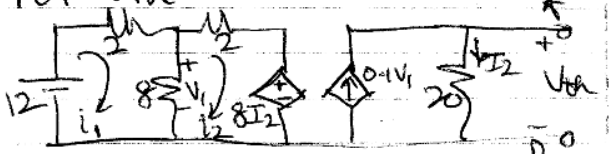
$I_1 = 3.333\ A$

$I_2 = 2.667\ A$

$V_1 = 8(I_1 - I_2) = 5.328V$

$\therefore I_{sc} = 0.1 V_1 = 0.5328$

For V_{th}



$I_2 = 0.1 V_1$ — (I)

$V_{th} = 20 I_2 = 2V_1$

By KVL to loop I :-

$10 i_1 - 8 i_2 = 12$ — (II)

KVL to loop II: $-8 i_1 + 10 i_2 = -8 I_2$

$-8 i_1 + 10 i_2 = -0.8 V_1$ [from (I)]

$-8 i_1 + 10 i_2 + 0.8 V_1 = 0$ — (III)

Also, $V_1 = 8(i_1 - i_2)$

$\therefore +8 i_1 - 8 i_2 - V_1 = 0$ — (IV)

$i_1 = 1.862$

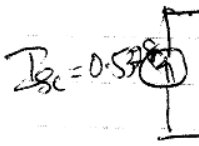
$i_2 = 0.828$

$V_1 = 8.276$

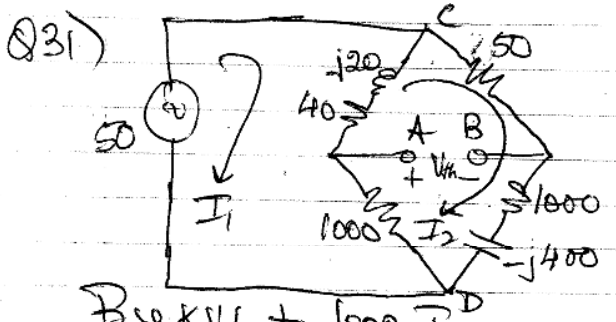
$V_{th} = 16.552V$

$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{16.552}{0.5328} = 31.067\Omega$

Norton's Eq ckt. is



Q31)



By KVL to loop I :-

$(40+j20+1000)I_1 - (40+j20+1000)I_2 = 50$

$\therefore (1040+j20)I_1 - (1040+j20)I_2 = 50$ —— (I)

By KVL to loop II :-

$-(1040+j20)I_1 + (1040+j20+1050-j400)I_2 = 0$

$-(1040+j20)I_1 + (2090-j380)I_2 = 0$

$I_1 = \left(\frac{2090-j380}{1040+j20}\right)I_2$ —— (II)

Subs (II) in (I)

$I_2\left[(2090-j380-1040-j20\right] = 50$

$I_2 = \frac{50}{1050-j400} = 0.0416+j0.0158$

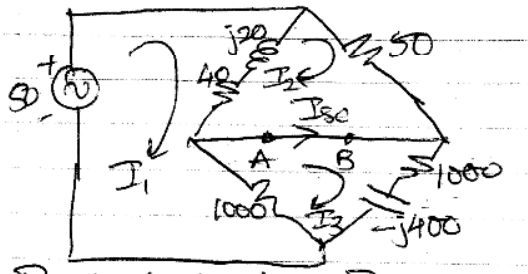
$I_1 = 0.0897+j0.0148$

By KVL to A-B-C-A -

$-(40+j20)I_1 + (90+j20)I_2 = V_{th}$

$V_{th} = 0.138 - j0.132 = 0.191\angle -43.7^\circ$

For I_{sc} :-



By KVL to loop I :-

$(1040+j20)I_1-(40+j20)I_2-1000I_3=50$ —(I)

By KVL to loop II :-

$-(40+j20)I_1+(90+j20)I_2=0$

$\therefore I_1=\left(\frac{90+j20}{40+j20}\right)I_2$ —(II)

By KVL to loop III :-

$-1000I_1+(2000-j400)I_2=0$

$\therefore I_1=\left(\frac{2000-j400}{1000}\right)I_3$ —(III)

[Use more sign. places]

from (II) & (III)

$\left(\frac{90+j20}{40+j20}\right)I_2=\left(\frac{2000-j400}{1000}\right)I_3$

$I_2=(0.988+j0.0471)I_3$ —(IV)

Subs. (III) & (IV) in (I) :-

$I_3(1049.42-j397.64)=50$

$I_3=0.04167+j0.0158$

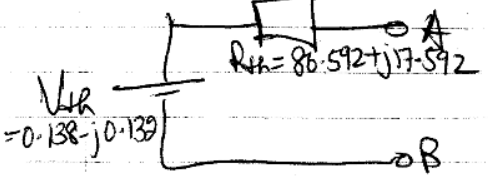
$\therefore I_2=0.0404+j0.0176$

$I_{sc}=I_3-I_2=0.00127-j0.0018$

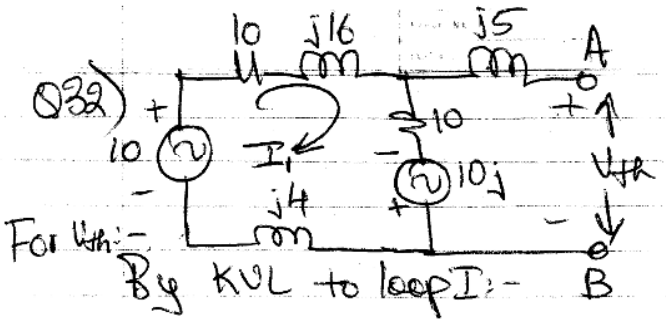
$R_{th}=\frac{V_{th}}{I_{sc}}=86.592+j17.592$

$I_{sc}=88.36\angle 11.48°$

Thevenin Eq. ckt is



Q32)



For V_{th}:-

By KVL to loop I:-

$(20+j20)I_1 = 10+j10$

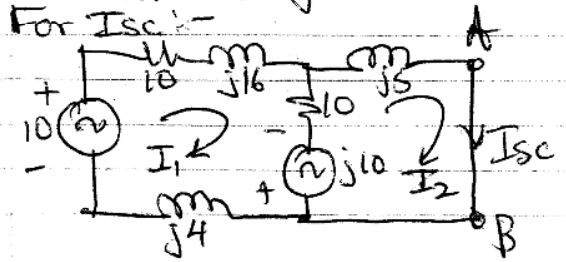
$I_1 = 0.5+j0$

By KVL to loop II:-

$V_{th} + 10j = 10I_1$

$\therefore V_{th} = 5-j10 = 11.18\angle -63.44°$

For Isc:-



By KVL to loop I:-

$(20+j20)I_1 - 10I_2 = 10+j10$ ——(I)

By KVL to loop II:-

$-10I_1 + (10+j5)I_2 = -j10$ ——(II)

$\Delta = \begin{vmatrix} 20+j20 & -10 \\ -10 & 10+j5 \end{vmatrix}$

$= j300$

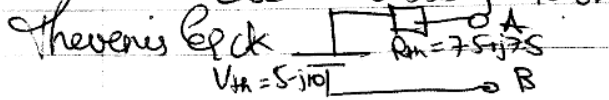
$\Delta_2 = \begin{vmatrix} 20+j20 & 10+j10 \\ -10 & -j10 \end{vmatrix}$

$= 300 - j100$

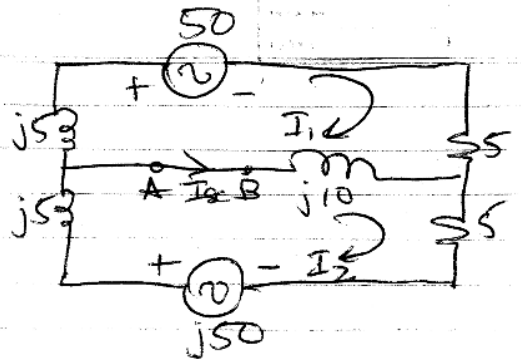
$I_2 = \frac{\Delta_2}{\Delta} = -0.333 - j$

$R_{th} = \frac{V_{th}}{I_{sc}} = \frac{5-j10}{-0.333-j} = 10.61\angle 45°$

Thevenin's eqv ckt



Q33)



By KVL to loop I:-

$(5+j15)I_1-(j10)I_2=-50$ —(I)

By KVL to loop II:-

$-(j10)I_1+(5+j15)I_2=j50$ —(II)

$$A=\begin{vmatrix} 5+j15 & -j10 \\ -j10 & 5+j15 \end{vmatrix}$$

$$=-100+j150$$

$$\Delta_1=\begin{vmatrix} -50 & -j10 \\ j50 & 5+j15 \end{vmatrix}=-750-250j$$

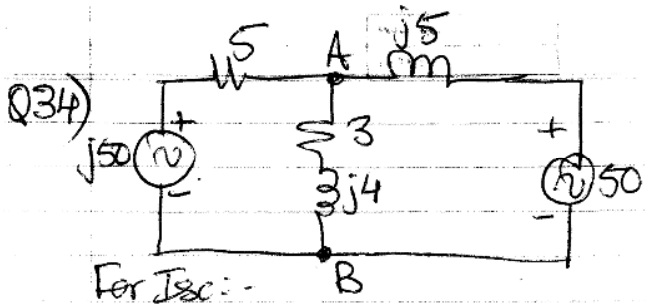
$$I_1=\frac{\Delta_1}{A}=1.154+j4.231$$

$$\Delta_2=\begin{vmatrix} 5+j15 & -50 \\ -j10 & j50 \end{vmatrix}$$

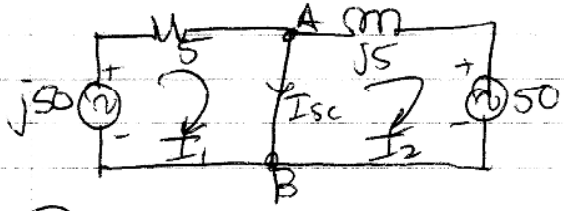
$$=-750-j250$$

$I_{sc}=I_2-I_1=$

Q34)



For I_{sc} :-



By KVL to loop I :-

$5I_1 = j50$

$\therefore I_1 = j10$

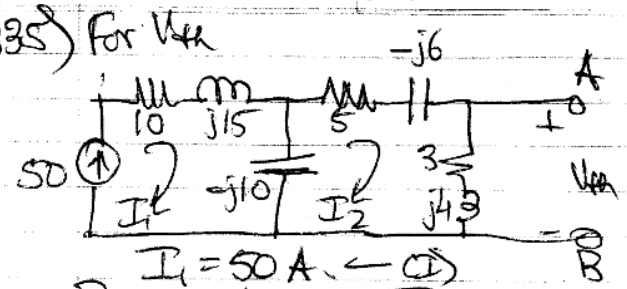
By KVL to loop II :-

$(j5)I_2 = -50$

$\therefore I_2 = j10$

$I_{sc} = I_1 - I_2 =$

Q35) For V_{th}



$I_1 = 50\,A \quad \leftarrow (I)$

By KVL to loop II :-

$(j10)I_1 + (8 - j12)I_2 = 0$

From (I)

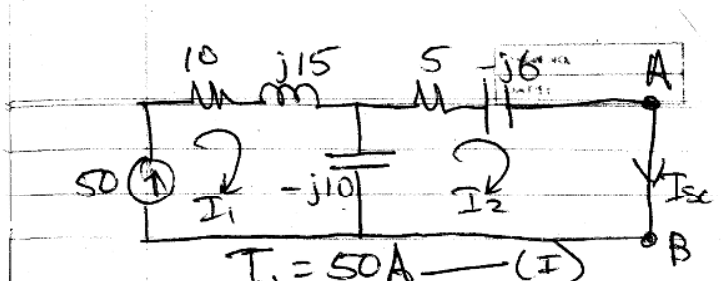
$I_2 = \frac{-50(j10)}{(8-j12)} = 28.85 j19.23$

$V_{th} = (3+j4)I_2$

$= 163.46 + j57.69$

For I_{sc}, short A-B

$3+j4 \,//\, \text{short} \simeq \text{short}$



$I_1 = 50\,A \quad (I)$

By KVL to loop II :-

$(j10)I_1 + (5 - j16)I_2 = 0$

$\therefore I_2 = \frac{-500j}{5-j16} = 28.47 - j8.897$

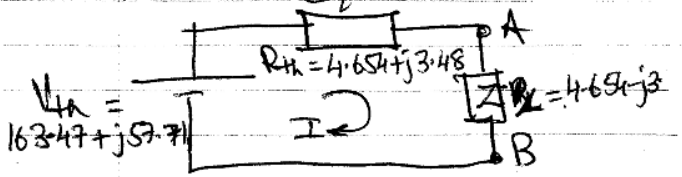
$I_{sc} = I_2 = 28.47 - j8.897$

For R_{th}

$R_{th} = \frac{V_{th}}{I_{sc}} = 4.654 + j3.481$

$R_L = R_{th} = 4.654 - j3.481$

Thevenin Eq. ckt. :



Max. power $= I^2 R_L$

$= \left(\frac{V_{th}}{Z_L + Z_{th}}\right)^2 \cdot R_L$

$= \frac{(163.47 + j57.71)^2}{(9.308)^2} \times (4.654)$

$= 1256.55\ W$

$I_L = \frac{V_{th}}{Z_L + Z_{th}} = 17.56 + j6.2$

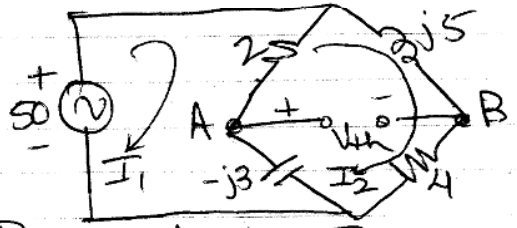
$|I_L| = 18.625$

$P = |I_L|^2 \cdot R_L$

$= (18.625)^2 \times (4.654)$

$= 1,614.36\ W$

836) For V_{th} :-



By KVL to loop I :-

$(2 - j3)I_1 + (2 - j3)I_2 = 50$ ——— (I)

By KVL to loop II :-

$-(2 - j3)I_1 + (6 + j2)I_2 = 0$

$I_1 = \frac{(6 + j2)}{(2 - j3)} I_2$ ——— (II)

Subs. (II) in (I)

$\left[(6 + j2) + (2 - j3)\right] I_2 = 50$

$I_2 = \frac{50}{8 - j} = 6.154 + j0.$

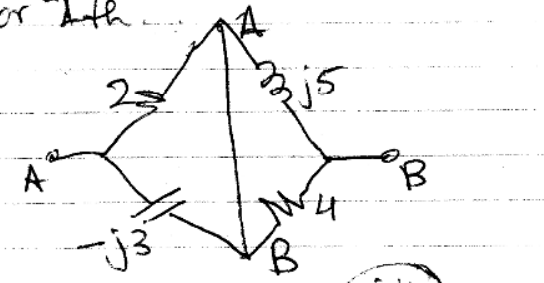
$I_1 = 1.539 + j10.77$

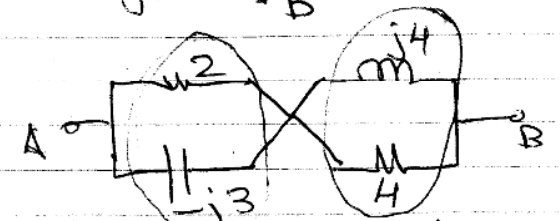
By KVL

$V_{th} = -2I_1 + (2+j5)I_2$

$V_{th} = 5.386 + j10.77$

For Z_{th} ...

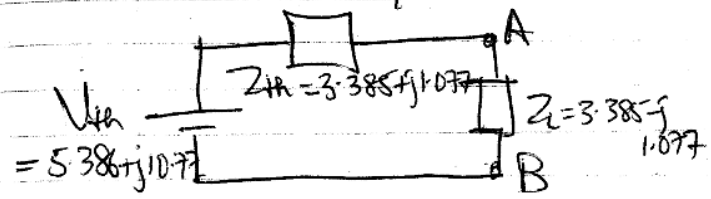




$Z_{th} = 3.385 + j1.077$

$Z_L = \overline{Z_{th}} = 3.385 - j1.079$

Thevenin Eq. ckt.



$P = I^2 R_L$

$= \left(\frac{V_{th}}{Z_L + Z_{th}}\right)^2 (R_L)$

$= \left(\frac{5.386 + j10.77}{6.77}\right)^2 \times (3.385)$

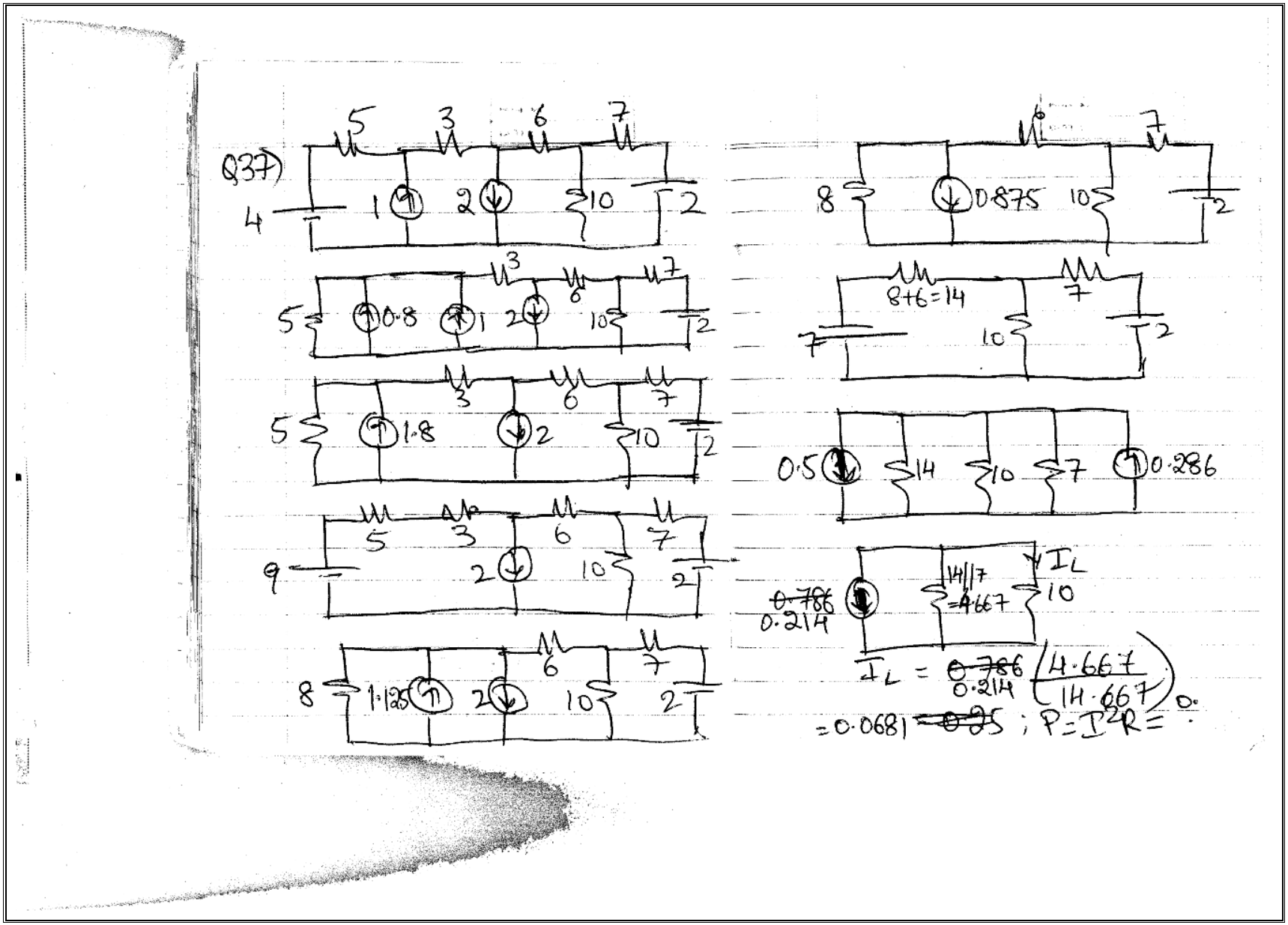
$I_L = \frac{V_{th}}{Z_L + Z_{th}} = 0.796 + j1.591$

$|I_L| = 1.779$

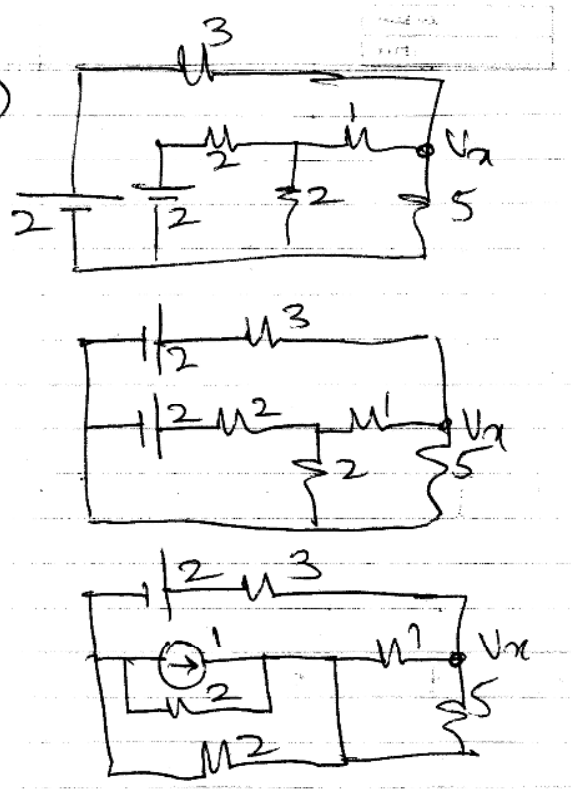
$P = I_L^2 R_L$

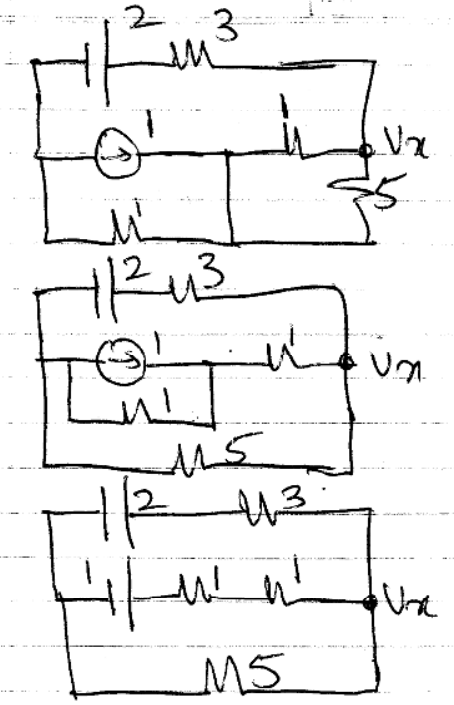
$= (1.779)^2 (3.385)$

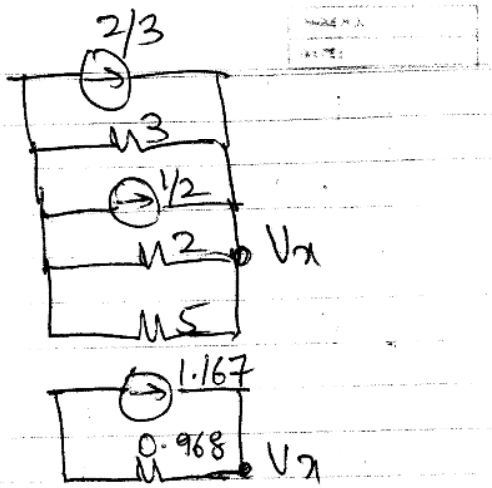
$= 10.71\,W$


Q37)
5
3
6
7
4
1
2
10
2
8
0.875
10
2
8+6=14
7
10
2
0.5
14
10
7
0.286
14||7
=4.667
10
I_L
0.786
0.214
I_L = 0.786/0.214 (4.667/14.667)
=0.0681
P=I²R=

(38)


3
2
1
Vx
2
2
2
5
2
3
2
2
1
Vx
2
5
2
3
2
1
Vx
2
5
2


2
3
1
1
Vx
5
1
2
3
1
1
Vx
1
5
2
3
1
1
1
Vx
5



$V_x = (1.167)(0.968)$
$= 1.129\,V$

Q39)