Problem (1)

Using Source Transformation find the current I_o in the circuit Of Fig (1).

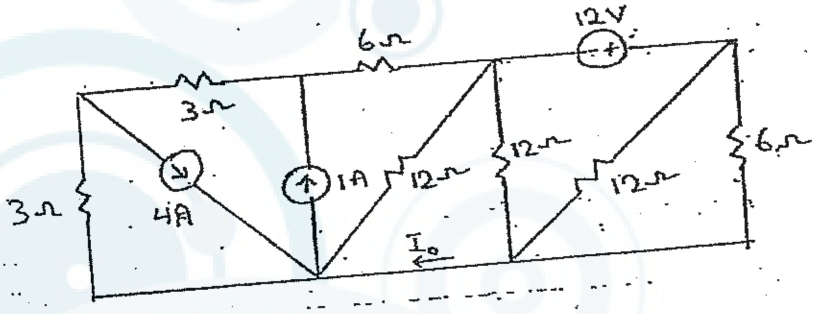


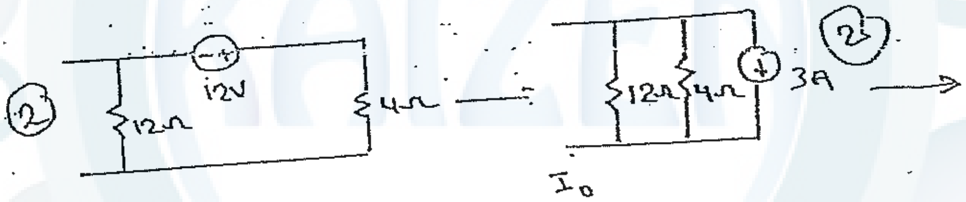
Fig (1)

Solution:

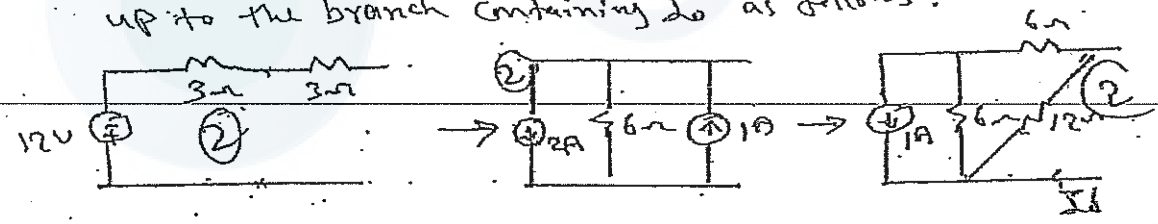
Starting from R.H.S. we have:

$$6 \| 12 = \frac{6 \times 12}{18} = 4\Omega$$

By source transformation we get:



Then we perform source transformation from L.H.S. up to the branch containing I_o as follows:



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Problem (2)

In the circuit of Fig (2), find the following:

(a) R_L Which will receive maximum power.

(b) The value of the maximum power transferred to R_L.

(c) Norton equivalent circuit between terminals of resistor R_L

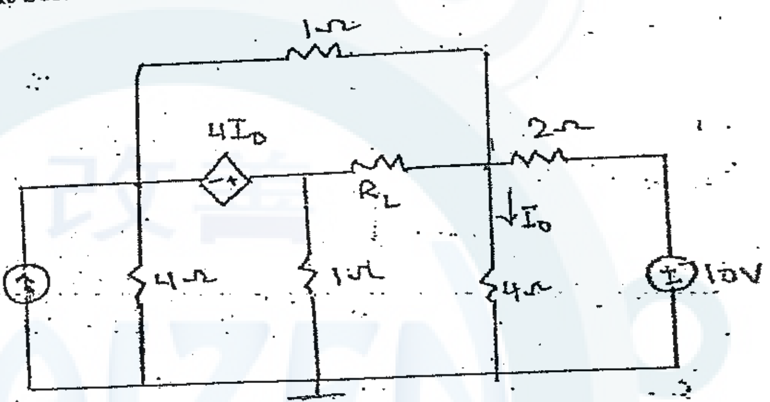


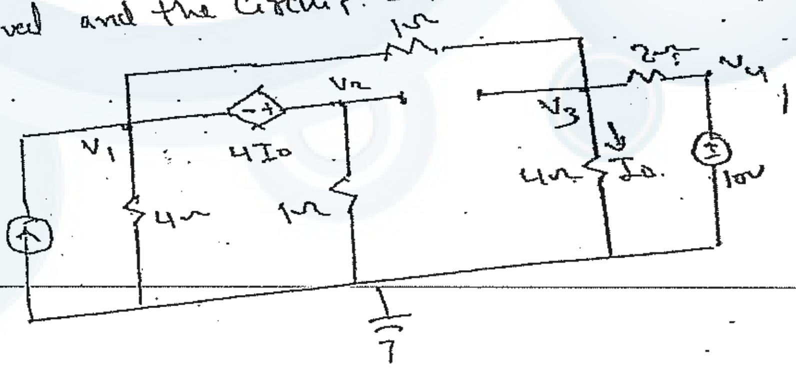
Fig (2)

Solution:

(a) (2) $R_L = R_{TH}$ to receive max. power

Since the circuit contains independent and dependent sources $R_{TH} = \dfrac{V_{o.c.}}{I_{s.c.}}$ (2)

R_L is removed and the circuit becomes as follows:



Calculation of $V_{o.c.}$

(1) $V_{o.c.} = V_{TH} = V_2 - V_3$

Applying nodal analysis we have:

at node 3 we have:

$0 = V_3\left(\frac{1}{1}+\frac{1}{4}+\frac{1}{2}\right) - \frac{V_1}{1} - \frac{10}{2}$ (3)

or $-4V_1 + 7V_3 = 20$ ---(1)

Problem (3)
In the circuit shown in Fig (3), find the admittance Y_{ab} in millimhos and in both Rectangular and Polar forms where $\omega = 500 rad/sec$

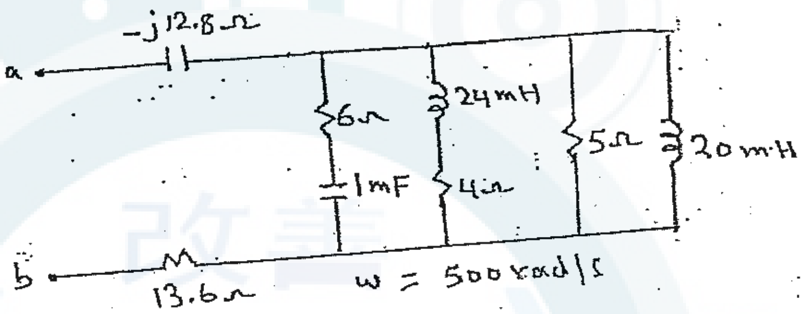


Fig (3)

Solution:

20mH $\longrightarrow$ $j \times 500 \times 20 \times 10^{-3} = j10\Omega$ (1)

24mH $\longrightarrow$ $j\,500 \times 24 \times 10^{-3} = j12\Omega$ (1)

1mF $\longrightarrow$ $-j\frac{1}{500 \times 1 \times 10^{-3}} = -j2\Omega$ (1)

We find the admittance for the four branches in parallel in the R.H.S. of fig.(3) and call it Y_1:

$$Y_1 = \frac{1}{6-j2} + \frac{1}{4+j12} + \frac{1}{5} + \frac{1}{j10} \quad (4)$$

$$= \frac{6+j2}{40} + \frac{4-j12}{160} + \frac{32}{160} - j0.1 \quad (2)$$

$$= \frac{60-j20}{160} = \frac{3-j1}{8} \quad (2)$$

$$Z_1 = \frac{1}{Y_1} = \frac{8}{3-j1} = 2.4+j0.8 \quad (2)$$

$$\therefore Z_{ab} = 13.6 - j12.8 + 2.4 + j0.8 = 16 - j12 \quad (2)$$

$$= 20\angle{-36.87^\circ} \quad (1)$$

$$\therefore Y_{ab} = 50\angle{36.87^\circ}\ m\mho = 40+j30\ m\mho \quad (1)$$

Problem (4)
In the circuit shown in Fig (4) and using Mesh Analysis find:

(a) The currents I_a, I_b, I_c, and, I_d in rectangular form and in time domain.

(b) Phase shift between each current in part (a) above and the relevant voltage across each element these currents are passing through.

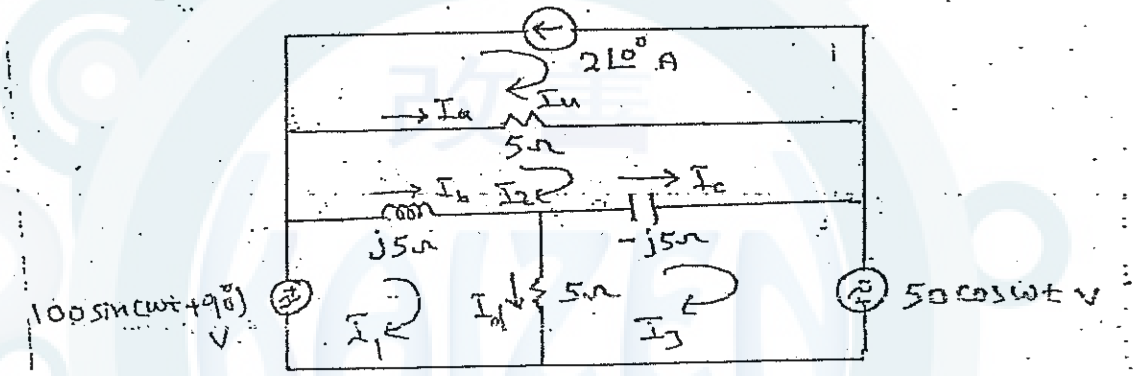


Fig (4)

Solution.

(a) In phasor domain voltage sources become:

① $100\angle 0^\circ$ V & $50\angle 0^\circ$ V ①

mesh #1:

$$100 = I_1(5+j5) - I_2 j5 - I_3 \times 5 \quad ---(1) \quad ②$$

mesh #2:

$$0 = -I_1 j5 + I_2(5+j5-j5) - I_u \times 5 + I_3 j5$$

But $I_u = -2\angle 0^\circ$ A

∴ above eqn. becomes:

② $$-10 = -j5I_1 + 5I_2 + j5I_3 \quad ---(2)$$

mesh #3:

$$50\angle 0 = -5I_1 + j5I_2 + (5-j5)I_3 \quad --(3)$$

Solving above 3 equations we get:

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Q1. Write one equation only to determine V_a in the circuit shown in Fig.1.

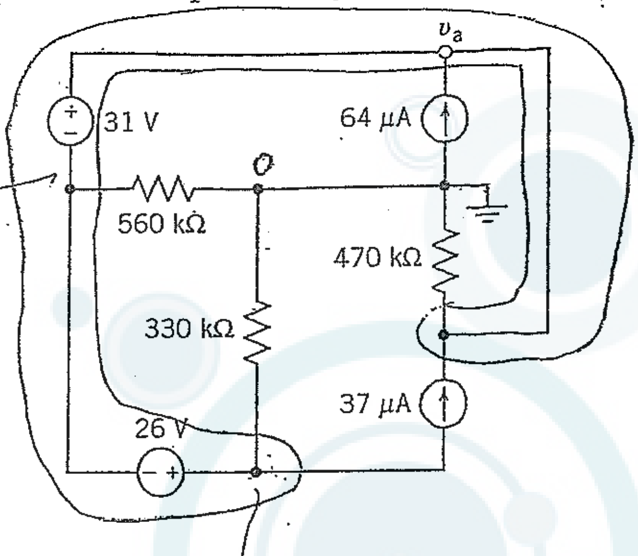


Fig. 1

$$-64\times10^{-6}+\frac{V_a}{470\times10^{3}}+\frac{V_a-31}{560\times10^{3}}+\frac{V_a-5}{330}=0$$

$$-64+2.12766V_a+1.785V_a-55.357+3.03V_a-15.15=0$$

$$6.94336\,V_a=134.508$$

$$V_a=19.37\,V$$

① ⑤

Problem 2:

Use mesh analysis method to find the two currents i_{10} and i_3 in the circuit of Fig. (2).

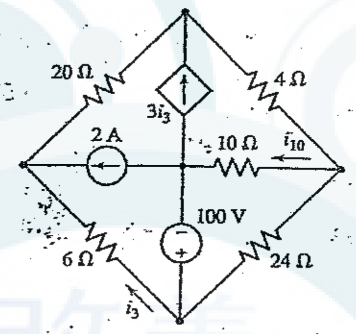
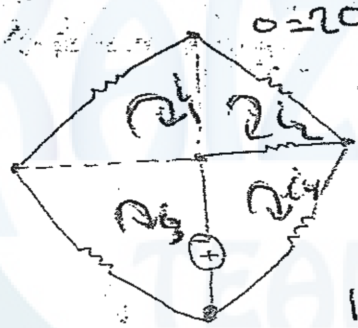


Fig.(2)

Solution

* On supermesh:

$0 = 20(i_1) + 4(i_2) + 10(i_2 - i_4) - 100 + 6(i_3)$



$20i_1 + 4i_2 + 10i_2 - 10i_4 + 6i_3 = 100$

$100 = 20i_1 + 14i_2 + 6i_3 - 10i_4$ — ①

10

* on the other mesh:

$100 + 10(i_4 - i_2) + 24(i_4) = 0$

6

$-100 = 10i_4 - 10i_2 + 24i_4$

$-100 = 34i_4 - 10i_2$ — ②

* relations between currents:

$3i_3 = i_2 - i_1$ — ③ $2 = i_1 - i_3$ — ④

Problem 3:

Use nodal analysis method to find v_4 in the circuit shown in Fig. (3).

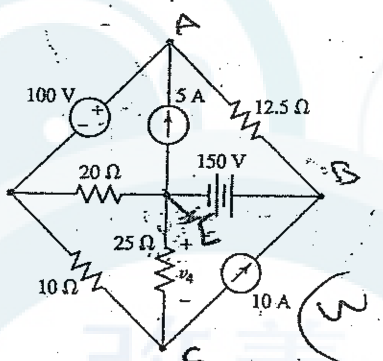


Fig. (3)

$\boxed{V_4 = -V_c}$

Solution

$*V_E = 0V \qquad V_B = 150V$ (2

*Super node at D and A:

$V_A - V_D = 100$ — ① (5

$\frac{V_A - V_B}{12.5} + \frac{V_D - V_c}{10} + \frac{V_D}{20} = 5$ (6

$.08V_A - .08V_B + .1V_D - .1V_c + .05V_D = 5$

$.08V_A + .15V_D - .1V_c = 5 + 12$

$.08V_A + .15V_D - .1V_c = 17$ — ②

*at node C:

$\frac{V_c - V_D}{10} + \frac{V_c}{25} = -10$ (5 $\Rightarrow .14V_c - .1V_D = -10$ — ③

$.1V_c - .1V_D + .04V_c = -10$

Problem (1)

Use Nodal Analysis method to find i_{40} and v_{20} in the circuit of Fig (1).
(Crossed wires not marked by a solid dot are not in physical contact).

$V_E = 0$

$V_B = V_A - 400$

$V_A - V_B = 400\,V$

$V_B - V_c = 4\,V_{20}$ $\quad V_{20} = V_c - V_d = V_c - 200$

$V_d = 200\,V$

$\Rightarrow V_B - V_c = 4(V_c - 200)$

$V_B - V_c = 4V_c - 800$

$V_B - 5V_c = -800 \quad (1)$

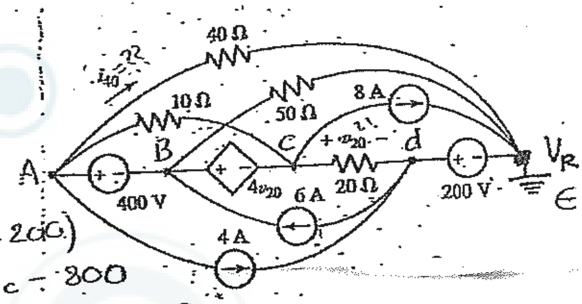


Fig (1)

at A + B, Super Node

$$+6 - 4 = V_A\left(\frac{1}{10} + \frac{1}{40}\right) - V_c\frac{1}{10} + V_B\frac{1}{50} = 0 \Rightarrow 2 = \frac{1}{8}V_A + \frac{1}{50}V_B - \frac{1}{10}V_c \quad (2)$$

at B + C ⇒ Super Node

$$-8 + 6 = V_B\left(\frac{1}{50}\right) + V_c\left(\frac{1}{20} + \frac{1}{10}\right) - V_d\frac{1}{20} - V_A\frac{1}{10}$$

$$\Rightarrow -2 = -\frac{1}{10}V_A + \frac{1}{50}V_B + \frac{3}{20}V_c - \frac{200}{20} \quad 10$$

$$8 = -\frac{1}{10}V_A + \frac{1}{50}V_B + \frac{3}{20}V_c$$

~~at d~~

$$\cancel{+4 - 6 = V_d\left(\frac{1}{20}\right) - V_c\left(\frac{1}{20}\right)}$$

$$\cancel{-2 = \frac{1}{20}(200) - \frac{1}{20}V_c}$$

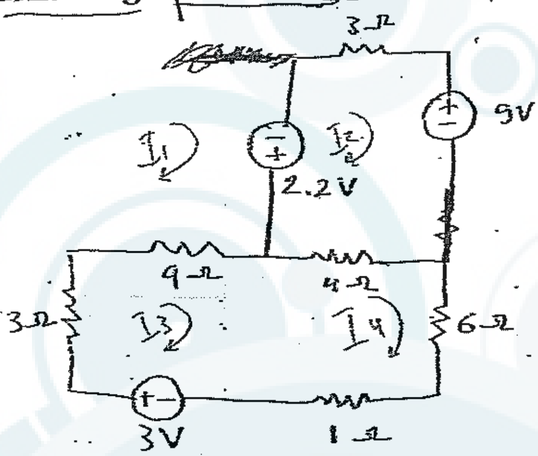
V_A

$$i_{40} = \frac{V_A}{40}$$

Abs

Problem (2)

In the circuit of Fig (2), use Mesh Analysis method to determine the power associated with the (2.2V) voltage source and state whether this source is delivering or absorbing power.



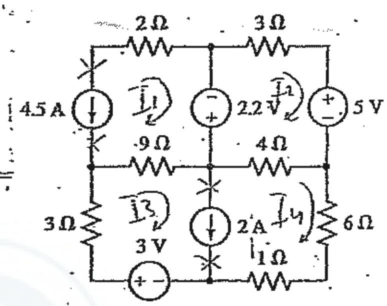


Fig (2)

$I_1 = -4.5\,A \quad \cdots (*)$

$I_3 - I_4 = 2\,A \quad \cdots (1)$

8

$$3 = \underbrace{I_3(3+9)}_{12 I_3} - 9\underbrace{I_1}_{-4.5} + \underbrace{I_4(4+6+1)}_{11 I_4} - 4 I_2 \quad \cdots (2)$$

6

$-4.5 = -1.5$

$$-5 - 2.2 = \underbrace{I_2(3+4)}_{7} - I_4(4) \quad \cdots (3)$$

4

$I_3 - I_4 = 2 \quad \cdots (1)$

$-4 I_2 + 12 I_3 + 11 I_4 = -1.5 \quad \cdots (2)$

$7 I_2 + 0 - 4 I_4 = -7.2 \quad (3)$

$$\begin{bmatrix} 0 & 1 & -1 \\ -4 & 12 & +11 \\ 7 & 0 & -4 \end{bmatrix}$$

$$I_2 = \frac{\begin{vmatrix} 2 & 1 & -1 \\ -1.5 & 12 & 11 \\ -7.2 & 0 & 4 \end{vmatrix}}{\begin{vmatrix} 0 & 1 & -1 \\ -4 & 12 & 11 \\ 7 & 0 & -4 \end{vmatrix}}$$

$$P = (I_2 - I_1)\,2.2$$

+

Absx

2

$$I_3 = \frac{\begin{vmatrix} 0 & 2 & -1 \\ -4 & -1.5 & 11 \\ 7 & -7.2 & 4 \end{vmatrix}}{}$$

$$I_4 = \frac{\begin{vmatrix} 0 & 1 & \\ -4 & 12 & 2 \\ & & -1.5 \\ 7 & 0 & -7.5 \end{vmatrix}}{\begin{matrix} 0 & 1 \\ -4 & 12 \\ 7 & 0 \end{matrix}}$$

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Problem 2:

The variable resistor in the circuit in Fig. (2) is adjusted for maximum power transfer to R_o.
What is the value of this max. power?

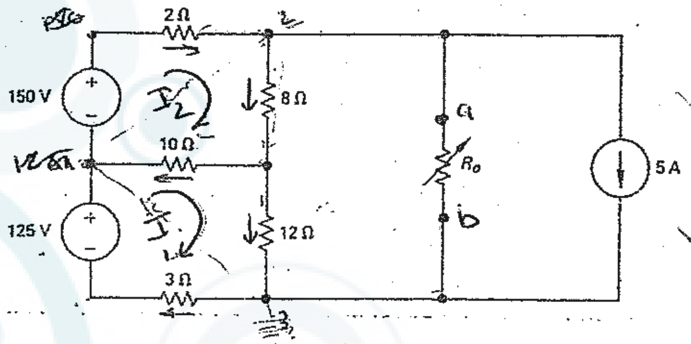
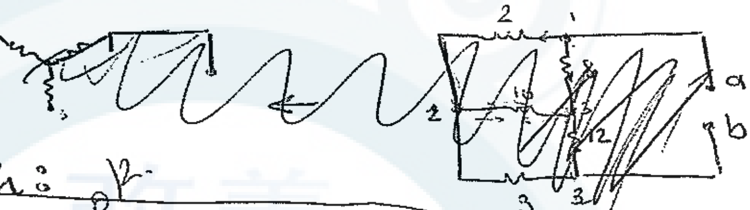


Fig. (2)

Solution

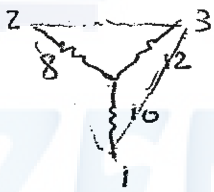


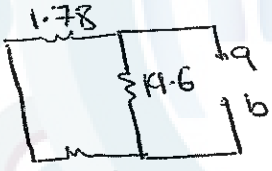
to calculate R_{th}:

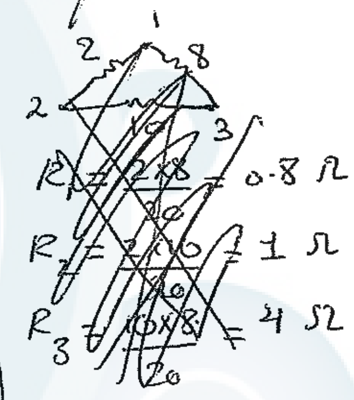
$$R_1 = \frac{10\times12+8\times12+8\times10}{10} = 19.6$$

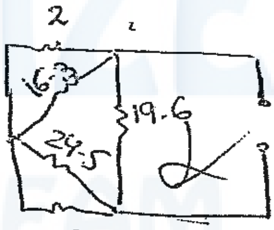
$$R_2 = \frac{196}{8} = 24.5$$

$$R_3 = \frac{196}{12} = 16.3$$









$$R_{th} = \frac{(1.78+2.67)*19.6}{(1.78+2.67)+19.6} = 3.63\ \Omega$$

$$150 - 2I_2 - 8I_2 - 10(I_2 - I_1) = 0$$

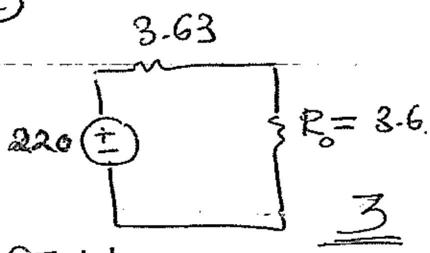
$$I_1(10) + I_2(-2-8-10) = -150 \quad \text{--- (1)}$$

$$125 + 10(I_2 - I_1) - 12I_1 - 3I_1 = 0$$

$$I_1(-10-12-3) + I_2(10) = -125 \quad \text{--- (2)}$$

$$I_1 = 10\text{ A}, \quad I_2 = 12.5\text{ A}$$

$$V_{th} = -3(10) + 125 + 150 - 2(12.5) = 220\text{ V}$$



$$\text{max } P_{max} = \left[220/(2*3.63)\right]^2 * 3.63 = 252.97\text{ W}$$

Problem (3)

In the circuit shown in Fig (3), use Superposition Principle to find the current i_Δ and the power developed in the dependent voltage source.

$53 i_\Delta$

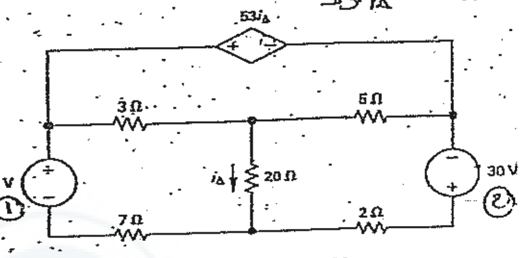


Fig (3)

i_Δ due to 30 $V_{①}$ only

Mech

$i_2 - i_3$

$-53 i_2 + 53 i_1 = 8I_1 - 3I_2 - 5I_3$

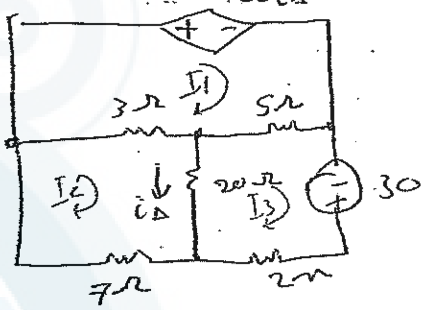
$0 = -45 I_1 + 50 I_2 - 5 I_3$

$-53 \underline{i_\Delta} = I_1 (3+5) - 3I_2 - 5I_3$

$30 = I_3 (20+2+5) - 5 I_1 - 20 I_2$

$0 = I_2 (7+3) + 20) - 20 I_3 - 3 I_1$

$53 i_\Delta$



$\Rightarrow 0 = -45 I_1 + 50 I_2 - 5 I_3$

$30 = -5 I_1 - 20 I_2 + \cancel{27} I_3$

$0 = -3 I_1 + \cancel{20} I_2 - 20 I_3$

$i_\Delta = I_2 - I_3$

$$\begin{bmatrix} -45 & 50 & -5 \\ -5 & -20 & 25 \\ -3 & 20 & -20 \end{bmatrix} \quad \begin{bmatrix} 0 \\ 30 \\ 0 \end{bmatrix}$$

$$I_1 = \frac{\begin{vmatrix} 0 & 50 & -5 \\ 30 & -20 & 25 \\ 0 & 20 & -20 \end{vmatrix}}{\begin{vmatrix} -45 & 50 & -5 \\ -5 & -20 & 25 \\ -3 & 20 & -20 \end{vmatrix}} = \quad \rightarrow \text{det}$$

$I_1 = \frac{-180}{13}$

$I_2 = \frac{-177}{13}$

$I_3 = \frac{-150}{13}$

28

$$I_2 = \frac{\begin{vmatrix} -45 & 0 & -5 \\ -5 & 30 & 25 \\ -3 & 0 & -20 \end{vmatrix}}{|\text{det}|} \qquad I_3 = \frac{\begin{vmatrix} -45 & 50 & 0 \\ -5 & -20 & 30 \\ -3 & 20 & 0 \end{vmatrix}}{|\text{det}|}$$

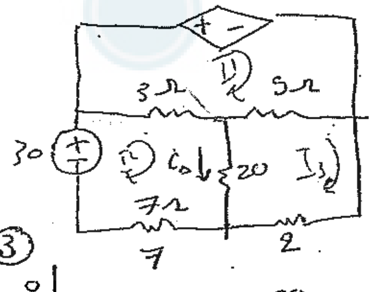
$-\frac{177}{13} + \frac{150}{13} = -\frac{27}{13}$

i_Δ'' due to 30 $V_{②}$ only

$0 = -45 + 50 I_2 - 5 I_3$

Mech

$53 i_\Delta$



$-53 (I_2 - I_3) = I_1 (8) - 3I_2 - 5I_3 \quad \cdots ①$

$30 = I_2 (20) - 20 I_3 - 3 I_1 \quad \cdots ②$

$0 = I_3 (27) - 5 I_1 - 20 I_2 \quad \cdots ③$

$$\begin{bmatrix} -45 & 50 & -5 \\ -3 & 20 & -20 \\ 5 & -20 & 27 \end{bmatrix} \qquad I_2 = \frac{\begin{vmatrix} -45 & 0 \\ -3 & 30 \\ -5 & 0 \end{vmatrix}}{\begin{vmatrix} -45 & 50 & -5 \\ -3 & 20 & -20 \\ -5 & -20 & 27 \end{vmatrix}} \qquad I_3 = \frac{\begin{vmatrix} -45 & 50 & 0 \\ -3 & 20 & 30 \\ -5 & -20 & 0 \end{vmatrix}}{\begin{vmatrix} -45 & 50 & -5 \\ -3 & 20 & -20 \\ -5 & -20 & 27 \end{vmatrix}}$$

$I_1 = -\frac{250}{13}$

$I_2 = -\frac{240}{13}$

$I_3 = -\frac{230}{13}$

$I_2 - I_3 = \frac{-10}{13}$