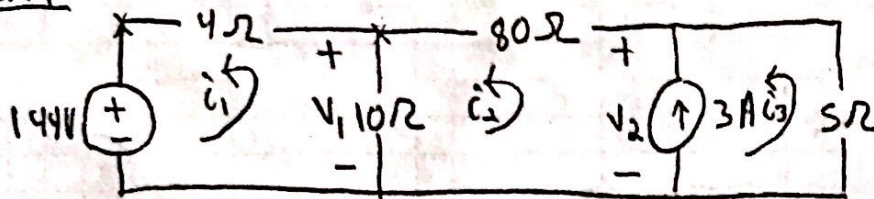


Problem 1



KVL 1

$$144 + (i_1 - i_2)10 + 4i_1 = 0$$

$$14i_1 - 10i_2 = -144$$

KVL 2

$$10(i_2 - i_1) + 80(i_2) - V_2 = 0$$

$$-10i_1 + 90i_2 - V_2 = 0$$

KVL 3

$$5V_2 + 5i_3 = 0$$

$$\begin{bmatrix} 14 & -10 & 0 & 0 \\ -10 & 90 & 0 & -1 \\ 0 & 0 & 5 & 1 \\ 0 & 4 & -1 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ V_2 \end{bmatrix} = \begin{bmatrix} -144 \\ 0 \\ 0 \\ 3 \end{bmatrix}$$

$$i_1 = -11A, i_2 = -1A, i_3 = -4$$

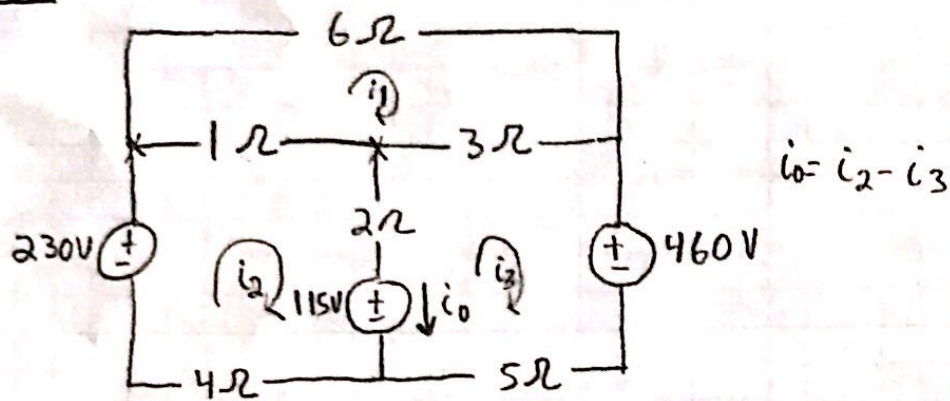
$$V_2 = 20V$$

$$V_1 = (i_1 - i_2)(10)$$

$$V_1 = (-11 + 1)(10)$$

$$V_1 = -100V$$

Problem 2



KVL 1

$$6(i_1) + 3(i_1 - i_3) + 1(i_1 - i_2) = 0$$

$$10i_1 - i_2 - 3i_3 = 0$$

KVL 2

$$1(i_2 - i_1) + 2(i_2 - i_3) + 115 + 4i_2 - 230 = 0$$

$$-i_1 + 7i_2 - 2i_3 = 115$$

KVL 3

$$3(i_3 - i_1) + 460 + 5i_3 - 115 + 2(i_3 - i_2) = 0$$

$$-3i_1 - 2i_2 + 10i_3 = -345$$

$$\begin{bmatrix} 10 & -1 & -3 \\ -1 & 7 & -2 \\ -3 & -2 & 10 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 115 \\ -345 \end{bmatrix}$$

$$i_1 = -10.6 \text{ A}$$

$$i_2 = 4.4 \text{ A}$$

$$i_3 = -36.8 \text{ A}$$

$$\sum P_V = -230(4.4) + 115(4.4 + 36.8) + 460(-36.8)$$

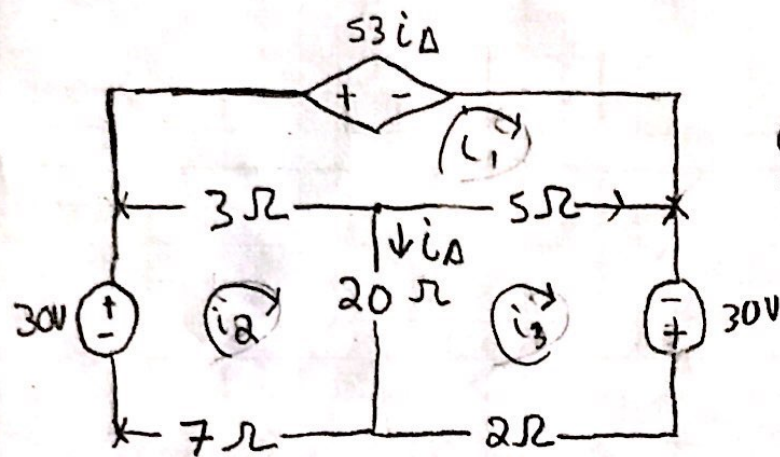
$$\sqrt{\sum P_V = -13202 \text{ W (delivered)}}$$

$$\sum P_{\text{Resistors}} = 6(i_1)^2 + 1(i_2 - i_1)^2 + 3(i_3 - i_1)^2 + 2(i_2 - i_3)^2 + 4i_2^2 + 5i_3^2$$

$$= 6(-10.6)^2 + 15^2 + 3(26.2)^2 + 2(41.2)^2 + 4(4.4)^2 + 5(36.8)^2$$

$$\sqrt{\sum P_{\text{Resistors}} = 13202 \text{ W}}$$

Problem 3



$$i_{\Delta} = i_2 - i_3$$

KVL 1

$$53i_{\Delta} + (i_1 - i_3)5 + (i_1 - i_2)3 = 0$$

$$8i_1 - 3i_2 - 5i_3 + 53i_{\Delta} = 0$$

KVL 2

$$-30 + (i_2 - i_1)3 + (i_2 - i_3)20 + 7i_2 = 0$$

$$-3i_1 + 30i_2 - 20i_3 = 30$$

KVL 3

$$-30 + 2i_3 + (i_3 - i_2)20 + (i_3 - i_1)5 = 0$$

$$-5i_1 - 20i_2 + 27i_3 = 30$$

Matrix

$$\begin{bmatrix} 8 & -3 & -5 & 53 \\ -3 & 30 & -20 & 0 \\ -5 & -20 & 27 & 0 \\ 0 & 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_{\Delta} \end{bmatrix} = \begin{bmatrix} 0 \\ 30 \\ 30 \\ 0 \end{bmatrix}$$

$$i_1 = 110 \text{ A}, \quad i_2 = 52 \text{ A}, \quad i_3 = 60 \text{ A}, \quad i_{\Delta} = -8 \text{ A}$$

$$P_{\text{dependent}} = 110(53(-8))$$

$$P_{\text{dependent}} = -46640 \text{ W (delivered)}$$

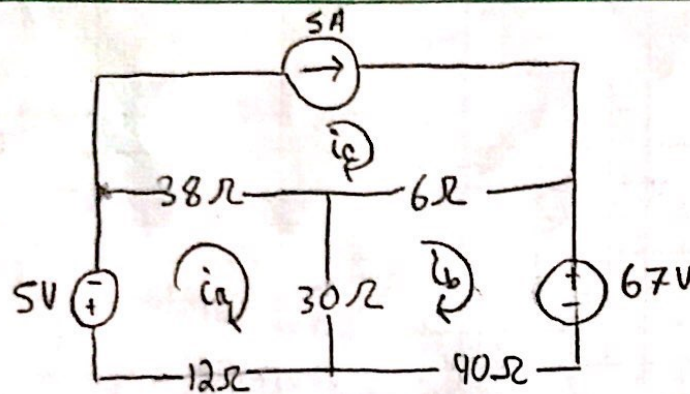
$$\text{LHS } P_{30V} = 30(52)$$

$$P_{30V} = 1560 \text{ W}$$

$$\text{RHS } P_{30V} = 30(60)$$

$$P_{30V} = 1800 \text{ W}$$

Problem 4



$$i_c = 5A$$

KVL A:

$$5V + (i_a - i_c) 38\Omega + (i_a - i_b) 30 + 12i_a = 0$$

$$40i_a - 30i_b = 185$$

KVL B

$$(i_b - i_a) 30 + (i_b - i_c) 6 + 67 + 40i_b = 0$$

$$76i_b - 30i_a = -37$$

$$\begin{bmatrix} 40 & -30 \\ -30 & 76 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \end{bmatrix} = \begin{bmatrix} 185 \\ -37 \end{bmatrix}$$

$$i_a = 2.5A$$

$$i_b = .5A$$

KVL C

$$V_c + (i_c - i_b) 6 + (i_c - i_a) 38 = 0$$

$$V_c = -122V$$

$$P_{SA} = -122(S)$$

$$\star P_{SA} = -610W$$

$$P_{67V} = 67(.5)$$

$$P_{67V} = 33.5W$$

$$P_{5V} = 5(2.5)$$

$$P_{5V} = 12.5W$$

Power dissipated by resistors

$$= 38(i_a - 5)^2 + 6(i_b - 5)^2 + 40(.5)^2 + 12(2.5)^2 + 30(.5 - 2.5)^2$$

$$\Sigma P_R = 564W$$

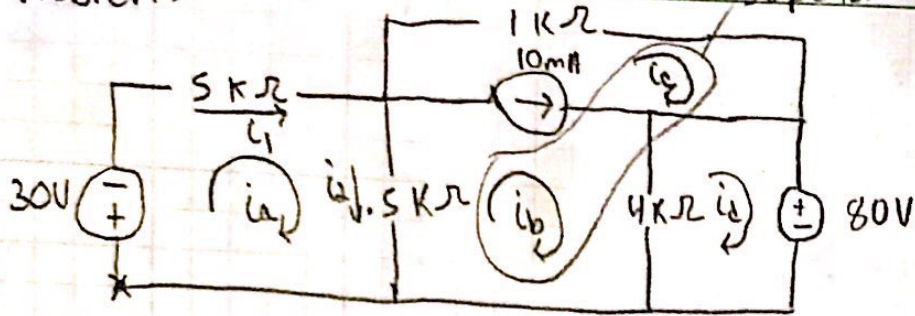
Total dissipated Power

$$\Sigma P_d = 564 + 33.5 + 12.5$$

$$\Sigma P_d = 610W$$

$$\boxed{\Sigma P_{dissipated} = \Sigma P_{delivered} = 610W}$$

Problem 5



KVL A:

$$30 + 5k\Omega i_a + (i_a - i_b) \cdot 5k\Omega = 0$$

$$5.5 i_a - .5 i_b = -30$$

KVL D:

$$80 + (i_d - i_b) 4k\Omega = 0$$

$$4 i_d - 4 i_b = -80$$

Supermesh:

$$5k\Omega (i_b - i_a) + 1k\Omega i_c + 4(i_c - i_d) = 0$$

$$-.5 i_a + 4.5 i_b + i_c - 4 i_d = 0$$

Constraint

$$i_b - i_c = 10mA$$

Matrice (Converted to Ω)

$$\begin{bmatrix} 5500 & -5000 & 0 & 0 \\ 0 & -4000 & 0 & 4000 \\ -500 & 4500 & 1000 & -4000 \\ 0 & 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \\ i_d \end{bmatrix} = \begin{bmatrix} -30 \\ -80 \\ 0 \\ .01 \end{bmatrix}$$

$$\begin{aligned} i_a &= -.01 A \\ i_b &= -.05 A \\ i_c &= -.06 A \\ i_d &= -.07 A \end{aligned}$$

$$i_1 = i_a$$

$$i_1 = -.01 A$$

$$i_2 = i_a - i_b$$

$$i_2 = 0.04 A$$

$$i_3 = i_d$$

$$i_3 = -.07 A$$