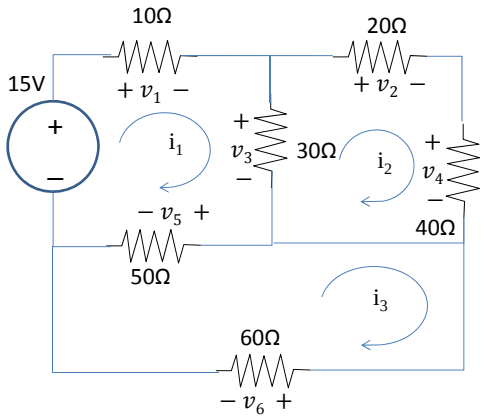
Problem 1



$v_1 = 10i_1$, $v_2 = 20i_2$, $v_3 = 30(i_1-i_2)$
$v_4 = 40i_2$, $v_5 = 50(i_1-i_3)$, $v_6 = 60i_3$

KVL around 3 meshes:

$$\begin{cases} v_1 + v_3 + v_5 - 15 = 0 \\ v_2 + v_4 - v_3 = 0 \\ v_6 - v_5 = 0 \end{cases}$$

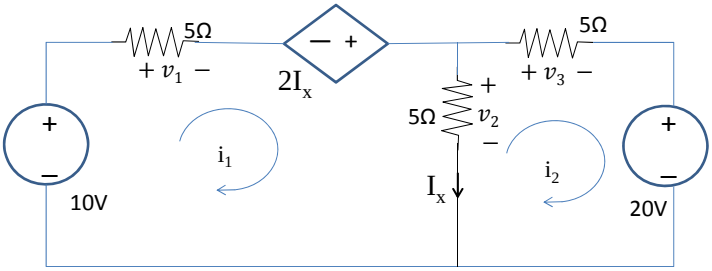
⇩

$$\begin{cases} 10i_1 + 30(i_1-i_2) + 50(i_1-i_3) - 15 = 0 \\ 20i_2 + 40i_2 - 30(i_1-i_2) = 0 \\ 60i_3 - 50(i_1-i_3) = 0 \end{cases}$$

⇩

$$\begin{cases} 18i_1 - 6i_2 - 10i_3 = 3 \\ -i_1 + 3i_2 = 0 \\ -5i_1 + 11i_3 = 0 \end{cases} \Rightarrow \boxed{\begin{cases} i_1 = 261.9\text{mA} \\ i_2 = 87.30\text{mA} \\ i_3 = 119.0\text{mA} \end{cases}}$$

Problem 2



$I_x = i_1 - i_2$, $v_1 = 5i_1$, $v_2 = 5I_x = 5(i_1-i_2)$, $v_3 = 5i_2$

$$\begin{cases} v_1 - 2I_x + v_2 - 10 = 0 \\ v_3 + 20 - v_2 = 0 \end{cases} \Rightarrow \begin{cases} 5i_1 - 2(i_1-i_2) + 5(i_1-i_2) - 10 = 0 \\ 5i_2 + 20 - 5(i_1-i_2) = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 8i_1 - 3i_2 = 10 \\ -i_1 + 2i_2 = -4 \end{cases} \Rightarrow \boxed{\begin{cases} i_1 = 0.615\text{A} \\ i_2 = -1.692\text{A} \end{cases}}$$

$$\boxed{I_x = i_1 - i_2 = 2.307\text{A}}$$

Problem 3

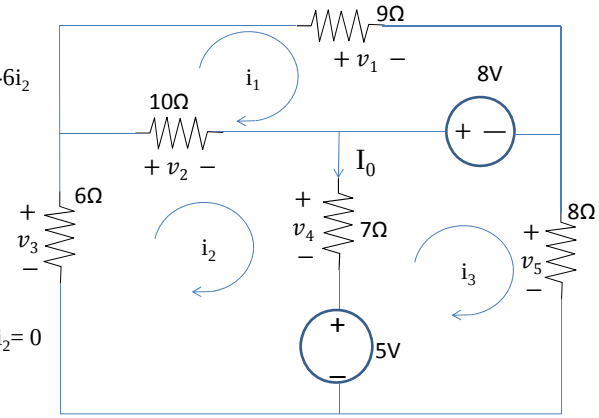
$v_1 = 9i_1$, $v_2 = 10(i_2 - i_1)$, $v_3 = -6i_2$
$v_4 = 7(i_2 - i_3)$, $v_5 = 8i_3$

$$\begin{cases} v_1 - 8 - v_2 = 0 \\ v_2 + v_4 + 5 - v_3 = 0 \\ 8 + v_5 - 5 - v_4 = 0 \end{cases}$$

$$\begin{cases} 9i_1 - 8 - 10(i_2 - i_1) = 0 \\ 10(i_2 - i_1) + 7(i_2 - i_3) + 5 + 6i_2 = 0 \\ 8 + 8i_3 - 5 - 7(i_2 - i_3) = 0 \end{cases}$$

$$\begin{cases} 19i_1 - 10i_2 = 8 \\ -10i_1 + 23i_2 - 7i_3 = -5 \\ -7i_2 + 15i_3 = -3 \end{cases} \Rightarrow \begin{cases} i_1 = 0.3414\text{A} \\ i_2 = -0.1513\text{A} \\ i_3 = -0.2706\text{A} \end{cases}$$

$I_0 = i_2 - i_3 = 0.1193\text{A}$



Problem 4

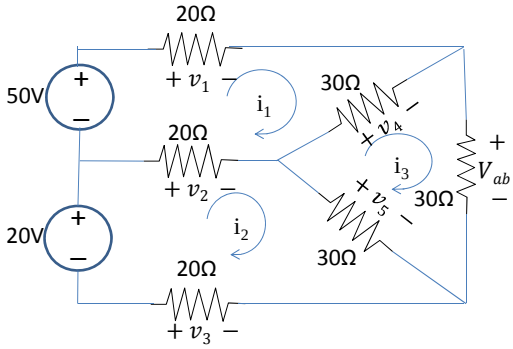
$v_1 = 20i_1$, $v_2 = 20(i_2 - i_1)$, $v_3 = -20i_2$
$v_4 = 30(i_3 - i_1)$, $v_5 = 30(i_2 - i_3)$, $v_{ab} = 30i_3$

$$\begin{cases} -50 + v_1 - v_4 - v_2 = 0 \\ -20 + v_2 + v_5 - v_3 = 0 \\ v_4 + V_{ab} - v_5 = 0 \end{cases}$$

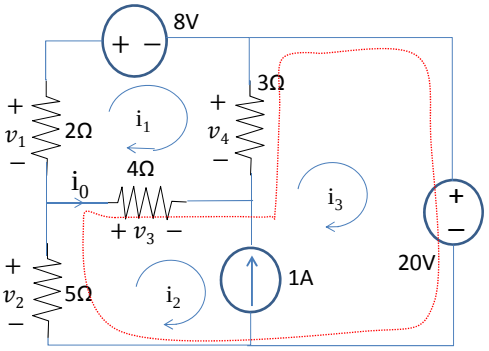
$$\begin{cases} -50 + 20i_1 - 30(i_3 - i_1) - 20(i_2 - i_1) = 0 \\ -20 + 20(i_2 - i_1) + 30(i_2 - i_3) + 20i_2 = 0 \\ 30(i_3 - i_1) + 30i_3 - 30(i_2 - i_3) = 0 \end{cases}$$

$$\begin{cases} 7i_1 - 2i_2 - 3i_3 = 5 \\ -2i_1 + 7i_2 - 3i_3 = 2 \\ i_1 + i_2 - 3i_3 = 0 \end{cases} \Rightarrow \begin{cases} i_1 = 1.333\text{A} \\ i_2 = 1\text{A} \\ i_3 = 0.778\text{A} \end{cases}$$

$V_{ab} = 30i_3 = 23.33\text{V}$



Problem 5



$v_1 = -2i_1$, $v_2 = -5i_2$, $v_3 = 4(i_2-i_1)$
$v_4 = 3(i_1 - i_3)$

Due to the current source,
a super-mesh needs to be formed

mesh 1: $8 + v_4 - v_3 - v_2 = 0;$
supermesh: $20 - v_2 + v_3 - v_4 = 0;$
by current source: $i_3 - i_2 = 1$

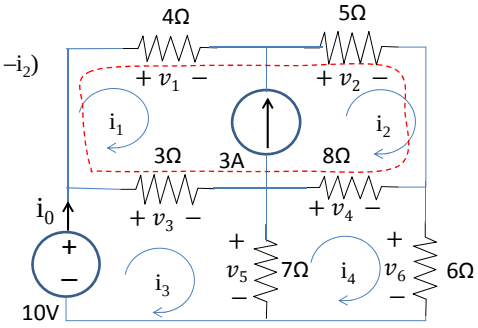
$8 + 4(i_1 - i_3) - 4(i_2 - i_1) + 2i_1 = 0;$
$20 + 5i_2 + 4(i_2 - i_1) - 4(i_1 - i_3) = 0;$
$i_3 - i_2 = 1$

$9i_1 - 4i_2 - 3i_3 = -8;$
$-7i_1 + 9i_2 + 3i_3 = -20;$
$-i_2 + i_3 = 1$

$i_1 = -3.746A$
$i_2 = -4.102A$
$i_3 = -3.102A$

$i_0 = i_2 - i_1 = -0.356A$

Problem 6



$v_1 = 4i_1$, $v_2 = 5i_2$, $v_3 = 3(i_3-i_1)$, $v_4 = 8(i_4 - i_2)$
$v_5 = 7(i_3-i_4)$, $v_6 = 6i_4$

Supermesh: $v_1 + v_2 - v_4 - v_3 = 0;$
Mesh 3: $v_3 + v_5 - 10 = 0;$
Mesh 4: $v_4 + v_6 - v_5 = 0;$
Current source : $i_2 - i_1 = 3$

$4i_1 + 5i_2 - 8(i_4 - i_2) - 3(i_3 - i_1) = 0$
$3(i_3 - i_1) + 7(i_3 - i_4) = 10$
$8(i_4 - i_2) + 6i_4 - 7(i_3 - i_4) = 0$
$i_2 - i_1 = 3$

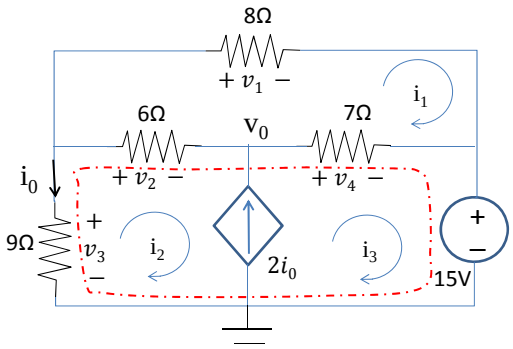
$7i_1 + 13i_2 - 3i_3 - 8i_4 = 0$
$-3i_1 + 10i_3 - 7i_4 = 10$
$-8i_2 - 7i_3 + 21i_4 = 0$
$-i_1 + i_2 = 3$

$i_1 = -1.297A$
$i_2 = 1.703A$
$i_3 = 1.389A$
$i_4 = 1.112A$

$i_0 = i_3 = 1.389A$

Problem 7

$v_1 = 8i_1, v_2 = 6(i_2 - i_1), v_3 = -9i_2$
$v_4 = 7(i_3 - i_1), \quad i_0 = -i_2$



Mesh 1: $v_1 - v_4 - v_2 = 0$
Supermesh: $v_2 + v_4 + 15 - v_3 = 0$
Current source : $i_3 - i_2 = 2i_0$

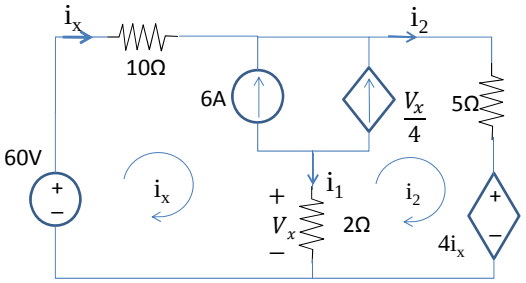
$8i_1 - 7(i_3 - i_1) - 6(i_2 - i_1) = 0$
$6(i_2 - i_1) + 7(i_3 - i_1) + 15 + 9i_2 = 0$
$i_3 - i_2 = -2i_2$

$21i_1 - 6i_2 - 7i_3 = 0$
$-13i_1 + 15i_2 + 7i_3 = -15$
$i_2 + i_3 = 0$

$i_1 = 0.0829A$
$i_2 = -1.740A$
$i_3 = 1.740A$

$i_0 = -i_2 = 1.740A$
$v_0 = 15 + v_4 = 15 + 7(1.740 - 0.0829)V = 26.600V$

Problem 8



$i_1 = \frac{V_x}{2}$
KCL at center node:
$i_1 + 6 + \frac{V_x}{4} = 0$

$V_x = -8V, \; i_1 = -4A$

$10i_x + 5i_2 + 4i_x = 60$; KVL along outer mesh
$i_x - i_2 = i_1 = -4$, KCL at bottom node

$14i_x + 5i_2 = 60;$
$i_x - i_2 = -4$

$i_2 = 6.105A;$
$i_x = 2.105A;$
$V_x = -8V$