MESH ANALYSIS WITH CURRENT SOURCES

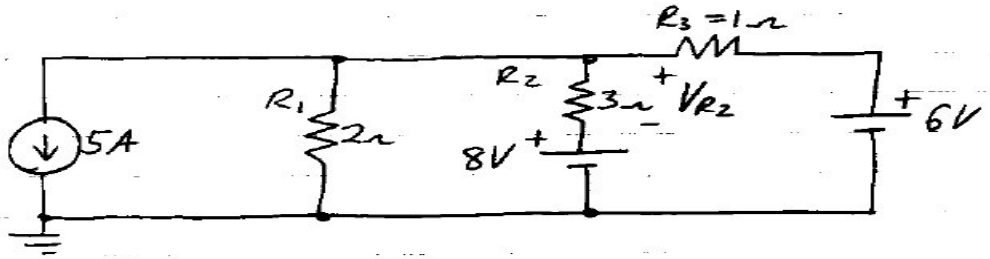
- 3 APPROACHES:

1) CONVERT THE CURRENT-SOURCE & PARALLEL RESISTANCE TO AN EQUIVALENT VOLTAGE SOURCE & SERIES RESISTANCE.

2) USE THE KNOWN CURRENT TO HELP SOLVE FOR THE MESH CURRENTS

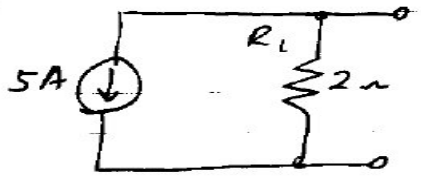
3) SUPERMESH APPROACH

(EXAMPLE)

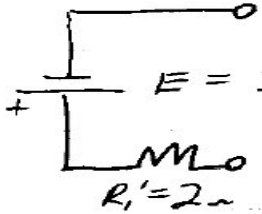


FIND: V_{R_2}

Approach 1:

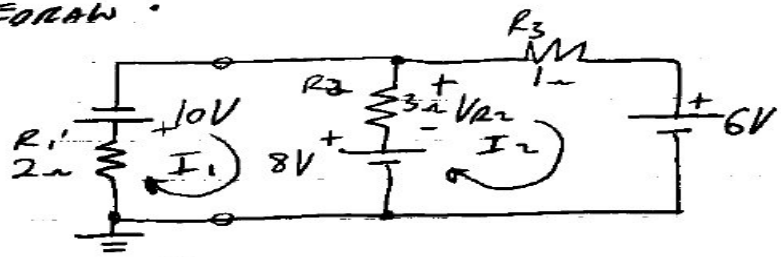


$\Rightarrow$



$E = I \cdot R = (5A)(2\Omega) = \underline{10V}$

REDRAW:



Loop 1: $-I_1 R_1' - 10 - I_1 R_2 + I_2 R_2 - 8 = 0$

$-18 = I_1(R_1' + R_2) - I_2 R_2$

$-18 = 5I_1 - 3I_2$ (1)

Loop 2: $8 - 3I_2 + 3I_1 - I_2 - 6 = 0$

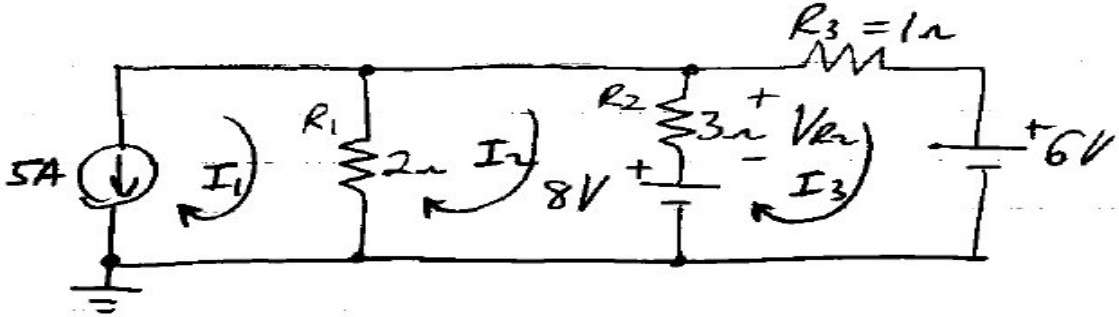
$2 = -3I_1 + 4I_2$ (2)

$\therefore \underline{I_1 = -6A}$

$\underline{I_2 = -4A}$

$\therefore V_{R_2} = (I_1 - I_2) R_2 = (-2A)(3\Omega) = \boxed{-6V}$

Approach 2:



Loop 1: $I_1 = \underline{-5A}$

Loop 2: $-I_2R_1 + I_1R_1 - I_2R_2 + I_3R_2 - 8 = 0$

$2I_1 - 5I_2 + 3I_3 = 8$

But $I_1 = -5A$

$\therefore\ -5I_2 + 3I_3 = 18 \qquad (1)$

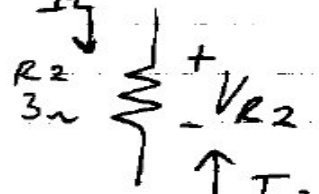
Loop 3: $8 - R_2I_3 + I_2R_2 - I_3R_3 - 6 = 0$

$3I_2 - I_3(4) = -2$

$\therefore\ 3I_2 - 4I_3 = -2 \qquad (2)$

Solve (1) & (2): $I_2 = \underline{-6A}$, $I_3 = \underline{-4A}$ } SAME AS BEFORE

V_{R_2}:

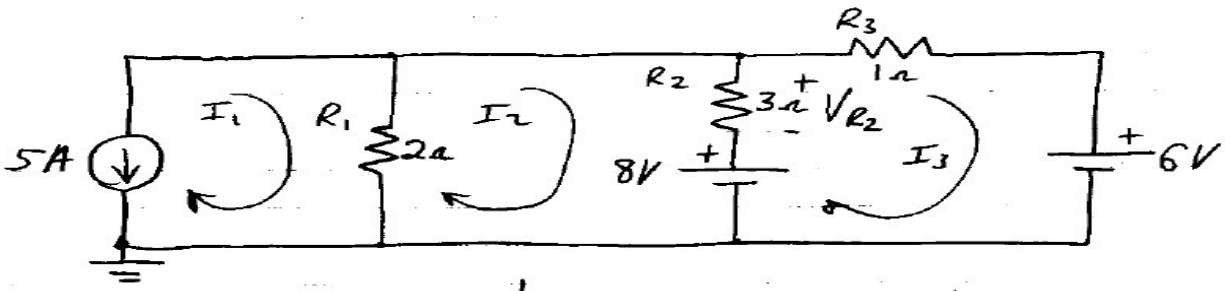


$V_{R_2} = (I_2 - I_3)R_2$

$= [-6 - (-4)]\ 3$

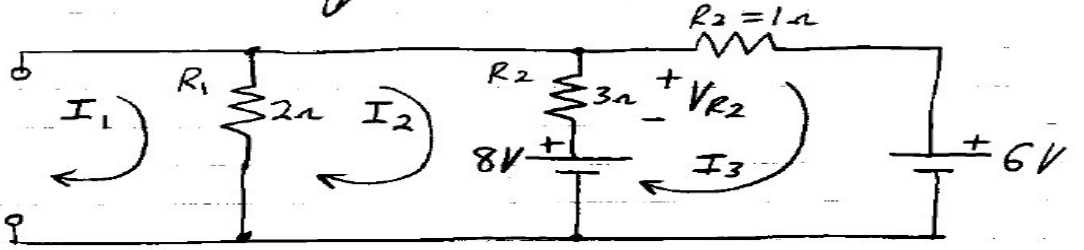
$= (-2)(3) = \boxed{-6V}$ ✓

APPROACH 3 - SUPERMESH (SAME CIRCUIT)



FIND V_{R_2}

REDRAW W/ CURRENT SOURCES OPEN CIRCUIT



APPLY KVL TO THE INDEPENDENT PATHS (I_2, I_3):

$$-(I_2-I_1)R_1 - (I_2-I_3)R_2 - 8 = 0$$
$$I_1R_1 + I_2(-R_1-R_2) + I_3R_2 = 8$$
$$2I_1 - 5I_2 + 3I_3 = 8 \qquad (1)$$

$$+8 - (I_3-I_2)R_2 - I_3R_3 - 6 = 0$$
$$I_2R_2 + I_3(-R_2-R_3) = 6-8$$
$$3I_2 - 4I_3 = -2 \qquad (2)$$

RELATE THE CURRENT SOURCE(S) TO THE MESH CURRENTS:

$$\underline{I_1 = -5A} \qquad (3)$$

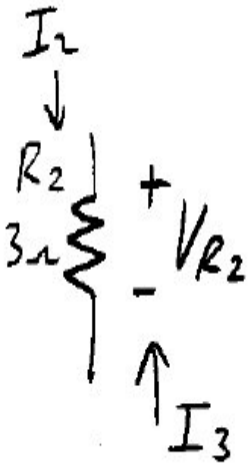
(3) INTO (1) YIELDS: $2(-5) - 5I_2 + 3I_3 = 8$

$$-5I_2 + 3I_3 = 18 \qquad (4)$$

SOLVE: (4) → $-5I_2 + 3I_3 = 18$
(2) → $3I_2 - 4I_3 = -2$

$I_2 = \underline{-6A}$
$I_3 = \underline{-4A}$

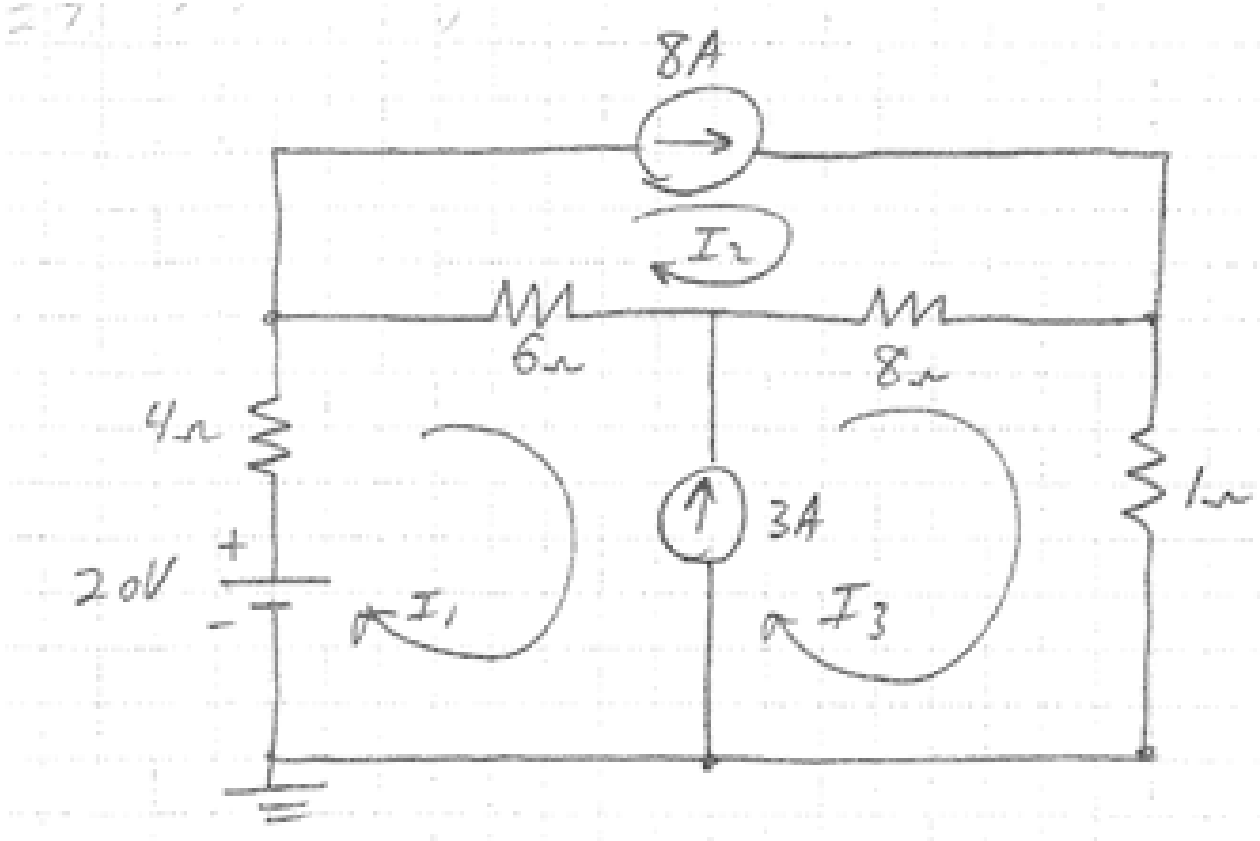
(SAME RESULT AS Appr. 1 & 2)



$$V_{R_2} = (I_2 - I_3)\, R_2$$
$$= [-6 - (-4)](3) = \boxed{-6V}$$

✓ SAME AS BEFORE

Breakout Problem #1



Find:

- The loop (MESH) currents as drawn
- The current (magnitude and direction) through the 20V source and also through the 6 ohm resistor