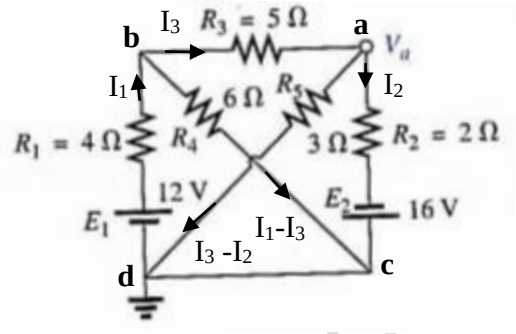
Q- Using mesh analysis, determine the current through $R_3 = 5\ \Omega$ resistance and the potential V_a.

Let the current in R_1 is I_1, R_2 is I_2 and R_3 is I_3. The currents in other resistors are indicated in the figure using the junction law.



Using the loop law for mesh dbcd we get

$\Sigma E = \Sigma IR$

Or $E_1 = I_1 R_1 + (I_1 - I_3)*R_4$

Or $12 = 4\ I_1 + 6*(I_1 - I_3)$

Or $10\ I_1 - 6\ I_3 = 12$

Or $5\ I_1 - 3\ I_3 = 6$ ---------- (1)

Using the loop law for mesh dbad we get

$\Sigma E = \Sigma IR$

Or $E_1 = I_1R_1 + I_3 R_3 + (I_3 - I_2)*R_5$

Or $12 = 4\ I_1 + 5\ I_3 + 3*(I_3 - I_2)$

Or $4\ I_1 - 3\ I_2 + 8\ I_3 = 12$ ---------- (2)

And for mesh acda we have

$\Sigma E = \Sigma IR$

Or $E_2 = I_2 R_2 - (I_3 - I_2)*R_5$

Or $16 = 2\ I_2 - 3*(I_3 - I_2)$

Or $5\ I_2 - 3\ I_3 = 16$ ---------- (3)

Substituting I_1 from (1) and I_3 from (3) in equation (2) we get

$$4\left(\frac{6+3I_3}{5}\right) - 3I_2 + 8\left(\frac{5I_2-16}{3}\right) = 12$$

Or $72 + 36\ I_3 - 45\ I_2 + 200\ I_2 - 640 = 180$

Or $155\ I_2 + 36\ I_3 = 748$ ---------- (4)

Solving equations (4) + (3)*12 we get

$215\ I_2 = 940$

Or $I_2 = 940/215 =$ **4.372 A**

Substituting in equation (3) we get

$I_3 = (5*4.372 - 16)/3 =$ **1.953 A**

Hence potential at b, Va is given by

$Va = I_2R_2 - E_2 = 4.372*2 - 16 =$ **- 7.356 V**

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