

5.11.2

AI25BTECH11003 - Bhavesh Gaikwad

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Question

Determine the current in each branch of the network shown in Fig.1

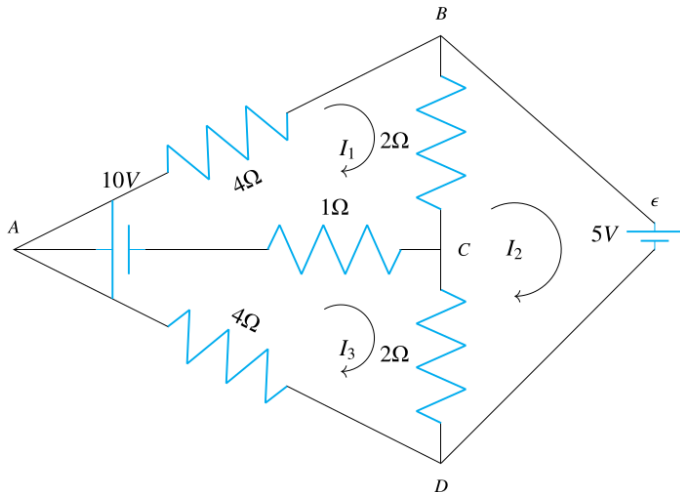


Figure: Fig.1

Theoretical Solution

Using mesh current analysis with Kirchhoff's Voltage Law (KVL) to solve the question.

Applying KVL to the loop ABCA,

$$-7I_1 + 2I_2 + I_3 = -10 \quad (1)$$

Applying KVL to the loop CBDC,

$$2I_1 - 4I_4 + 2I_3 = -5 \quad (2)$$

Applying KVL to the loop ACDA,

$$-I_1 - 2I_2 + 7I_3 = 10 \quad (3)$$

Therefore, the Three equations are:

$$-7I_1 + 2I_2 + I_3 = -10$$

$$2I_1 - 4I_4 + 2I_3 = -5$$

$$-I_1 - 2I_2 + 7I_3 = 10$$

Theoretical Solution

$$\text{Let } \mathbf{M} = \begin{pmatrix} -7 & 2 & 1 \\ 2 & -4 & 2 \\ -1 & -2 & 7 \end{pmatrix} \text{ and } \mathbf{x} = \begin{pmatrix} l_1 \\ l_2 \\ l_3 \end{pmatrix} \text{ and } \mathbf{T} = \begin{pmatrix} -10 \\ -5 \\ 10 \end{pmatrix}$$

$$\therefore \mathbf{M}\mathbf{x} = \mathbf{T} \quad (4)$$

OR

$$\begin{pmatrix} -7 & 2 & 1 \\ 2 & -4 & 2 \\ -1 & -2 & 7 \end{pmatrix} \mathbf{x} = \begin{pmatrix} -10 \\ -5 \\ 10 \end{pmatrix} \quad (5)$$

The Augmented Matrix:

$$\left(\begin{array}{ccc|c} -7 & 2 & 1 & -10 \\ 2 & -4 & 2 & -5 \\ -1 & -2 & 7 & 10 \end{array} \right) \quad (6)$$

Theoretical Solution

Row Transformation-1: $R_3 \rightarrow R_3 + R_1$

$$\left(\begin{array}{ccc|c} -7 & 2 & 1 & -10 \\ 2 & -4 & 2 & -5 \\ -8 & 0 & 8 & 0 \end{array} \right) \quad (7)$$

Row Transformation-2: $R_2 \rightarrow R_2 + \frac{R_3}{4}$

$$\left(\begin{array}{ccc|c} -7 & 2 & 1 & -10 \\ 0 & -4 & 4 & -5 \\ -8 & 0 & 8 & 0 \end{array} \right) \quad (8)$$

Row Transformation-3: $R_3 \rightarrow R_3 - \frac{8R_1}{7} - \frac{4R_2}{7}$

$$\left(\begin{array}{ccc|c} -7 & 2 & 1 & -10 \\ 0 & -4 & 4 & -5 \\ 0 & 0 & 32/7 & -60/7 \end{array} \right) \quad (9)$$

Theoretical Solution

$$\begin{pmatrix} -7 & 2 & 1 \\ 0 & -4 & 4 \\ 0 & 0 & 32/7 \end{pmatrix} \begin{pmatrix} l_1 \\ l_2 \\ l_3 \end{pmatrix} = \begin{pmatrix} -10 \\ -5 \\ -60/7 \end{pmatrix} \quad (10)$$

$$\boxed{\therefore l_1 = 55/56A, l_2 = 5/8A, l_3 = 15/8} \quad (11)$$