Topic 5

Node Voltage Method

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Node Voltage Method or point analysis

The node voltage method of analysis solves for unknown voltages at circuit nodes in terms of a system of KCL equations.

Let's use this circuit (Fig. 3) to illustrate the method:

There must be -----

1. Node

2. Connection between nodes through branch

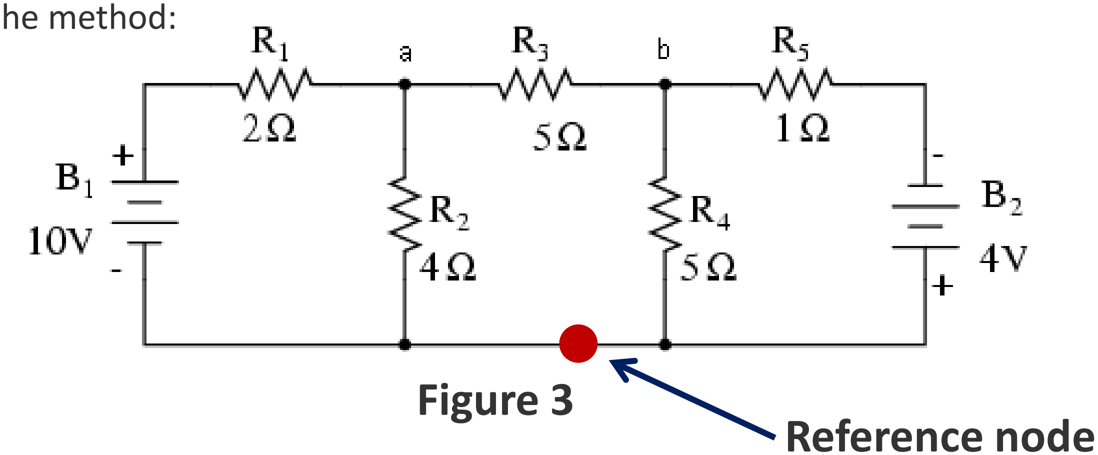


Figure 3

Apply KCL to

Node a:

Fixed –ve

Entering I to node –ve
Leaving I from node +ve

$$V_a\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) - \frac{V_b}{R_3} - \frac{10}{R_1} = 0$$

Directly connected resistors to the node
i.e. R_1, R_2, R_3

Relation with other nodes
i.e. node b

Enter/leave current to/from the node
i.e. current due to B_1 and R_1

Applying KCL at node 'a'

$$V_a\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)-\frac{V_b}{R_3}-\frac{10}{R_1}=0$$

$$V_a\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{5}\right)-\frac{V_b}{5}-\frac{10}{2}=0$$

$$19V_a-4V_b=100 \text{ ------------------ } \text{Equ}^n\ (1)$$

Applying KCL at node 'b'

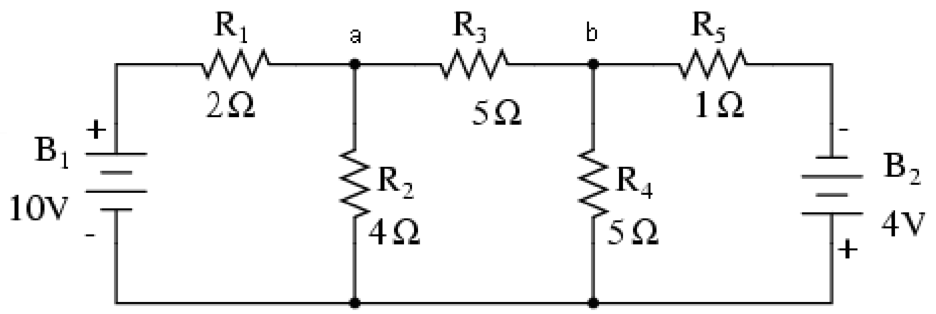
$$V_b\left(\frac{1}{R_5}+\frac{1}{R_4}+\frac{1}{R_3}\right)-\frac{V_a}{R_3}+\frac{4}{R_5}=0$$

$$V_b\left(\frac{1}{1}+\frac{1}{5}+\frac{1}{5}\right)-\frac{V_a}{5}+\frac{4}{1}=0$$

$$V_a-7V_b=20 \text{ ----------------- } \text{Equ}^n\ (2)$$

Matrix format

$$\begin{vmatrix}19 & -4\\ 1 & -7\end{vmatrix}=\begin{vmatrix}100\\ 20\end{vmatrix}$$



Substituting equ^n (1) & (2) we have,

$$D=\begin{vmatrix}19 & -4\\ 1 & -7\end{vmatrix}=-133+4=-129$$

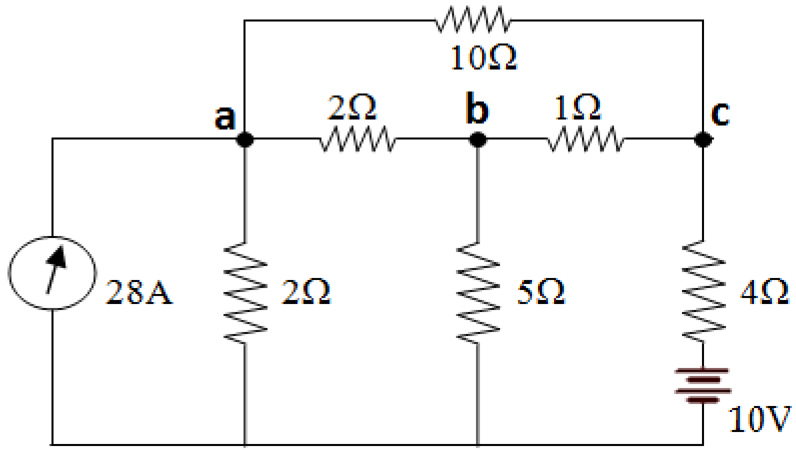
$$V_a=\frac{\begin{vmatrix}100 & -4\\ 20 & -7\end{vmatrix}}{-129}=\frac{-700+80}{-129}=4.81V$$

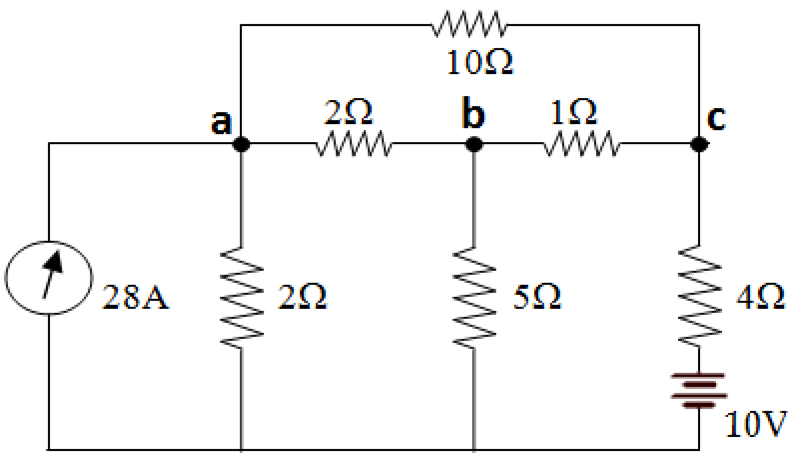
$$V_b=\frac{\begin{vmatrix}19 & 100\\ 1 & 20\end{vmatrix}}{-129}=\frac{380-100}{-129}=2.17V$$

$$I_1=\frac{V_a-B_1}{R_1};\qquad I_2=\frac{V_a}{R_2};\qquad I_3=\frac{V_a-V_b}{R_3};$$

$$I_4=\frac{V_b}{R_4};\qquad I_5=\frac{V_b-B_2}{R_5}$$

Problem-1: Determine the currents through and voltages across each branch of the network using node voltage method





10Ω
a
2Ω
b
1Ω
c
28A
2Ω
5Ω
4Ω
10V