

Case Study - 1

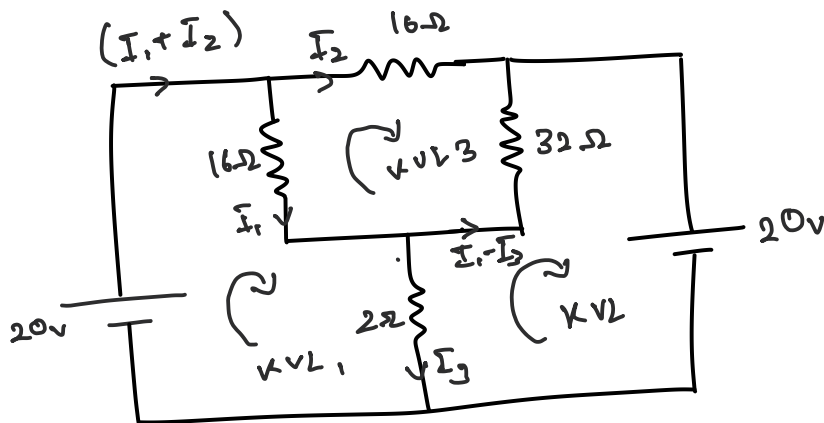
Statement:

6 Electrical resistor network node voltage solver

23BME018

7 Use Kirchhoff current law to form linear equations for a multi node DC circuit and compute unknown voltages.

Circuit:



For KVL-1 loop:

$$V \text{ across } 16\Omega \Rightarrow \underline{16 \times I_1}$$

$$\text{across } 2\Omega \Rightarrow \underline{2 \times I_3}$$

$$20V = 16I_1 + 2I_3 \quad \text{--- (1)}$$

for KVL-2 loop:

$$V \text{ across } 32\Omega \Rightarrow (I_1 - I_2) \times 32$$

$$\text{across } 2\Omega \Rightarrow (I_3) \times 2$$

$$0 = 20 - 2I_3 - 32(I_1 - I_3)$$

$$20 = 2I_3 + 32(I_1 - I_3)$$

$$\left[20 = 32I_1 - 30I_3 \right] \quad \text{--- (2)}$$

For KVL - 3 loop :

$$\begin{aligned} V \text{ across } 16 \Omega &= 16 \times I_1 \\ \text{across } 16 \Omega &= 16 \times I_2 \\ \text{across } 32 \Omega &= 32(I_1 - I_3) \end{aligned}$$

$$16 I_1 + 16 I_2 - 32(I_1 - I_3) = 0$$

$$\left[0 = I_1 - I_2 - 2I_3 \right] \text{ ————— } \textcircled{3}$$

Equation form to be

$$\begin{aligned} \textcircled{1} \quad 16 I_1 + 0 I_2 + 2 I_3 &= 20 \\ \textcircled{2} \quad 32 I_1 + 0 I_2 - 30 I_3 &= 20 \\ \textcircled{3} \quad I_1 - I_2 - 2 I_3 &= 0 \end{aligned}$$

forming $[A][x] = [B]$ matrix

$$\begin{bmatrix} 16 & 0 & 2 \\ 32 & 0 & -30 \\ 1 & -1 & -2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 20 \\ 20 \\ 0 \end{bmatrix}$$

Solving via matlab.

```
1 A = [16 0 2; 32 0 -30; 1 -1 -2];
2
3 B = [20; 20; 0];
4
5 X = A \ B;
6
7 I1 = X(1)
8 I2 = X(2)
9 I3 = X(3)
10
```

Result via code:

```
I1 =
```

```
1.1765
```

```
I2 =
```

```
0
```

```
I3 =
```

```
0.5882
```