Basic Electrical Engineering (TEE 101)

Lecture 7: Nodal Analysis Numerical Practice

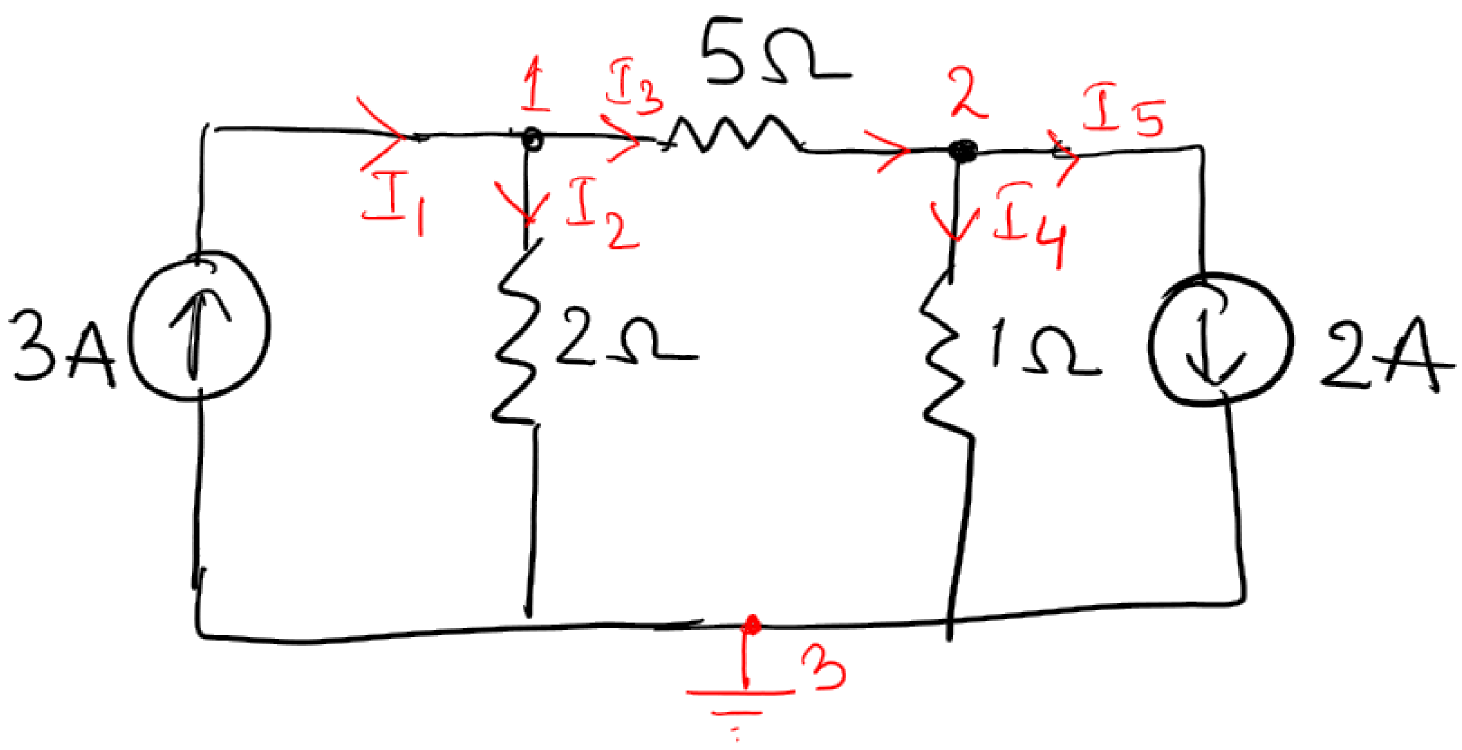
Content

This lecture covers the numerical practice on Nodal Analysis for the circuits with:

- **Only Current Sources**
- **Super Node**

Electric Circuit with only current Sources

Determine the current through all resistances using Nodal Analysis in the circuit shown below:



Step 1: No. of $J^n = 3$

2 → Independent nodes

1 → Reference

Step 2 :→ Mark all Junctions

(Let Junction be marked as 1, 2 and 3)

Step 3 :→ Assume voltage at each Junction.

The voltage at J^n 1 and 2 is V_1 and V_2 respectively.

Reference J^n is at ZERO volts

Step 4 :→ Assume current and their directions of each independent principle node.

Let these currents are :

I_1, I_2 and I_3 at J^n 1

I_3, I_4 and I_5 at J^n 2

We can assume any direction of these currents around each J^n.

(The directions are marked in the circuit)

Step 5 : Apply KCL at Junction 1 and 2

The KCL eq^n of J^n 1 is

$$I_1 = I_2 + I_3 \quad \text{———} \; (1)$$

$$I_1 = 3A \; ; \; I_2 = \frac{V_1}{2} \; ; \; I_3 = \frac{V_1 - V_2}{5}$$

So, eq^n 1 can be modified as :

$$3 = \frac{V_1}{2} + \frac{V_1 - V_2}{5}$$

or, $$\frac{5V_1 + 2V_1 - 2V_2}{10} = 3$$

$$\boxed{7V_1 - 2V_2 = 30} \quad \text{———} \; (2)$$

Similarly, the KCL equation of Junction 2 is :

$I_3 = I_4 + I_5$ ——— 3

$I_3 = \frac{V_1 - V_2}{5}$; $I_4 = \frac{V_2}{1}$; $I_5 = 2A$

Substitute these in eq^n 3 ; we get

$$\frac{V_1 - V_2}{5} = \frac{V_2}{1} + 2$$

$$V_1 - V_2 = 5V_2 + 10$$

$$\boxed{V_1 - 6V_2 = 10}$$ ——— 4

Now, we can solve eq^n 2 and 4 to determine the node voltages V_1 & V_2.

$$[7V_1 - 2V_2 = 30] \times 1$$
$$[V_1 - 6V_2 = 10] \times 7$$

$$\cancel{7V_1} - 2V_2 = 30$$
$$\cancel{7V_1} - 42V_2 = 70$$
$$- \quad + \quad -$$

$$40V_2 = -40$$

$$\boxed{V_2 = -1\ V}$$ ——— 5

using this value of V_2 ; the value of V_1 obtained is :

$$\boxed{V_1 = 4V}$$ ——— 6

Now using the values of these node voltages we can find I_2, I_3 & I_4

$$I_2 = \frac{V_1}{2} = \frac{4}{2} = \boxed{2A}$$

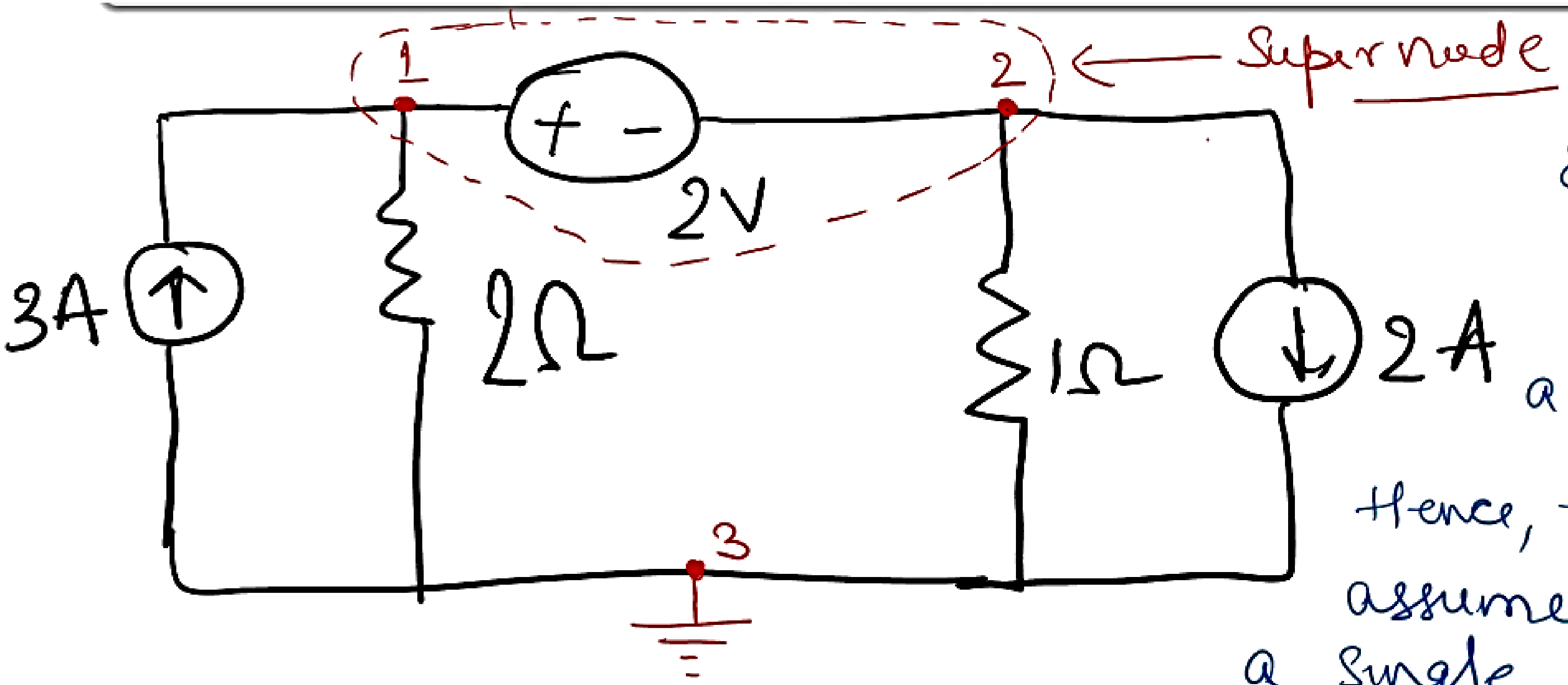
$$I_4 = \frac{V_2}{1} = \frac{-1}{1} \boxed{= -1A}$$

$$I_3 = \frac{V_1 - V_2}{5} = \frac{4-(-1)}{5} = \frac{5}{5} = \boxed{1A}$$

Answers.

Electric Circuit with Super node Case

Determine the current through all resistances using Nodal Analysis in the circuit shown below:

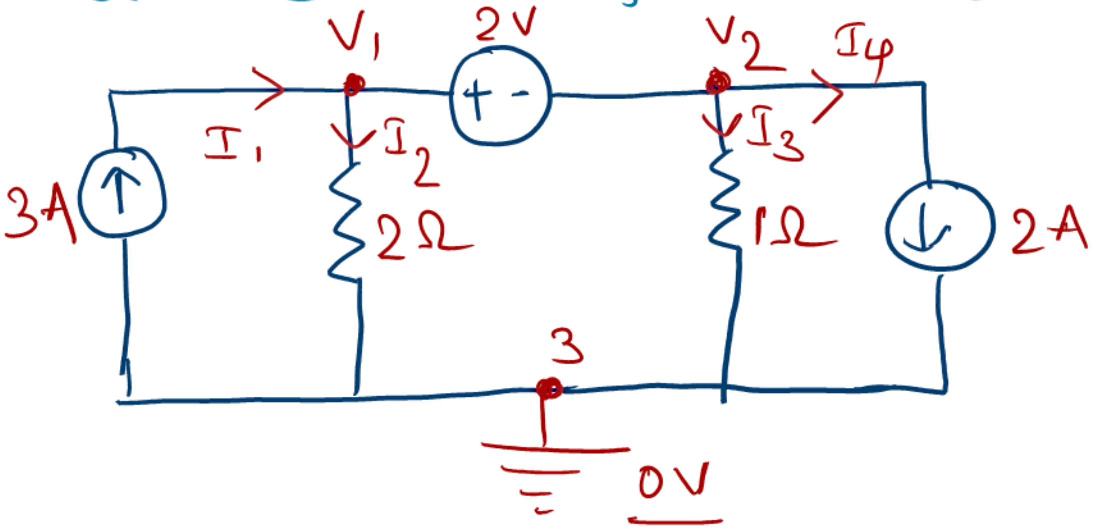


In this circuit, J^n ① and ② are connected through a voltage source.

Hence, these two J^n are assumed to behave as a single J^n or node, known as Supernode.

Now the Nodal Analysis will be applied in similar manner in this case also. The only difference is that this circuit has Super Node.

Let us draw the circuit showing all the currents and their directions



The KCL Equation at Supernode is

$$I_1 = I_2 + I_3 + I_4 \qquad \text{——— (1)}$$

$I_1 = 3A$; $I_2 = \dfrac{V_1}{2}$; $I_3 = \dfrac{V_2}{1}$;

$I_4 = 2A$

eqⁿ (1) Can be written as :

$$3 = \frac{V_1}{2} + \frac{V_2}{1} + 2$$

or, $\dfrac{V_1 + 2V_2 + 4}{2} = 3$

or, $V_1 + 2V_2 + 4 = 6$

or, $\boxed{V_1 + 2V_2 = 2}$ ——— (2)

Now, The voltage difference between Jⁿ (1) and (2) is

$$\boxed{V_1 - V_2 = 2} \qquad \text{——— (3)}$$

Now, we can solve eqⁿ (2) and (3) to calculate V_1 and V_2 and Hence, the value of I_2 and I_3 can be calculated.

Now, let's write the two eqⁿs once again

$$V_1 + 2V_2 = 2$$
$$V_1 - V_2 = 2$$
$$- \quad + \quad -$$

$$3V_2 = 0$$

$$\boxed{V_2 = 0\ V} \text{ ——— } (4)$$

Now, using the value of V_2, we can determine V_1 as:

$$V_1 - 0 = 2$$

$$\boxed{V_1 = 2V} \text{ ——— } (5)$$

Hence, the value of

$$I_2 = \frac{V_1}{2} = \frac{2}{2} = \boxed{1\ A}$$

and

$$I_3 = \frac{V_2}{1} = \frac{0}{1} = \boxed{0\ A}$$

Answer

Thus, In this case, $1\,\Omega$ resistor does not have any current.

Thank You