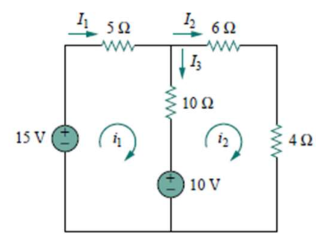
Tutorial Sheet-2 (Unit-1)

Q1. For the circuit in Fig., find the branch currents I_1, I_2, and I_3 using mesh analysis.



Ans1: i1 = i2 = 1 A

We first obtain the mesh currents using KVL. For mesh 1,

$$-15 + 5i_1 + 10(i_1 - i_2) + 10 = 0$$

or

$$3i_1 - 2i_2 = 1$$

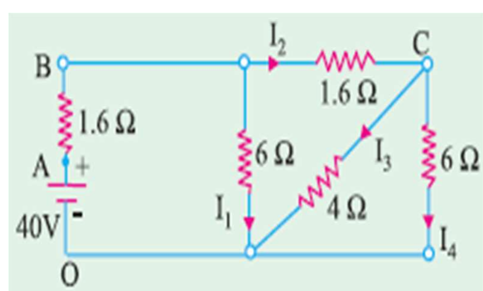
For mesh 2,

$$6i_2 + 4i_2 + 10(i_2 - i_1) - 10 = 0$$

or

$$i_1 = 2i_2 - 1$$

Q2. Find current through 4Ω resistance.



Ans2:

Solution. Simplifying the series-parallel combinations, and solving the circuit, the source current is 10 amp. With respect to 0, $V_A = 40$, $V_B = 40 - 16 = 24$ volts.

I_1 = 4 amp, hence $I_2 = 6$ amp

$V_C = V_B - I_2 \times 1.6 = 24 - 9.6 = 14.4$ volts

$I_3 = 14.4/4 = 3.6$ amp, which is the required answer. Further $I_4 = 24$ amp.

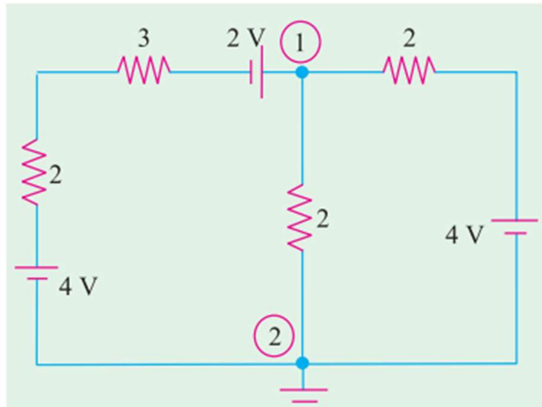
Q3: *Using Node voltage method, find the current in the 3Ω resistance for the network.*

Ans 3:

Solution. As shown in the figure node 2 has been taken as the reference node. We will now find the value of node voltage V_1. Using the technique developed in Art. 2.10, we get

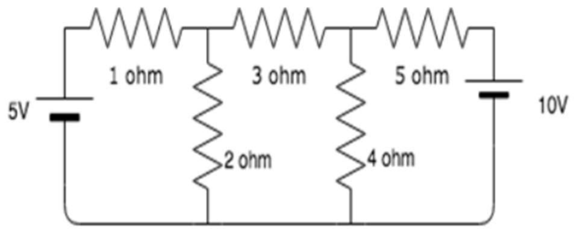
$$V_1\left(\frac{1}{5}+\frac{1}{2}+\frac{1}{2}\right)-\frac{4}{2}-\left(\frac{4+2}{5}\right)=0$$

The reason for adding the two battery voltages of 2 V and 4 V is because they are connected in additive series. Simplifying above, we get $V_1 = 8/3$ V. The current flowing through the 3 Ω resistance towards node 1 is $= \frac{6-(8/3)}{(3+2)} = \frac{2}{3}$ A



Q4.

1. Find the value of the currents I1, I2 and I3 flowing clockwise in the first, second and third mesh respectively.



Ans.

Explanation: The three mesh equations are:

-3I1+2I2-5=0

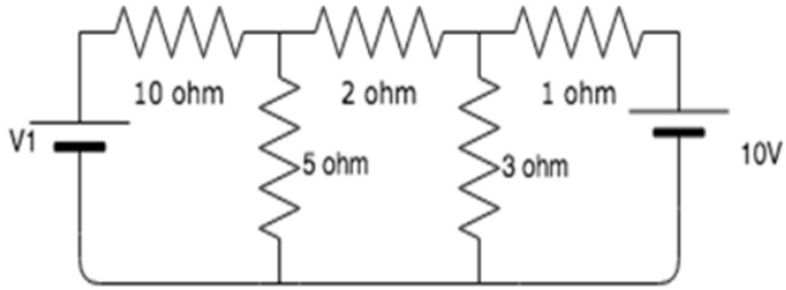
2I1-9I2+4I3=0

4I2-9I3-10=0

Solving the equations, we get I1= 1.54A, I2=-0.189 and I3= -1.195A.

Q5.

[redacted] Find the value of V1 if the current through the 1 ohm resistor=0A.



Ans.

Explanation: Taking I1, I2 and I3 as the currents in the three meshes and taking I3=0 since it is the current across the 1 ohm resistor, the three mesh equations are:

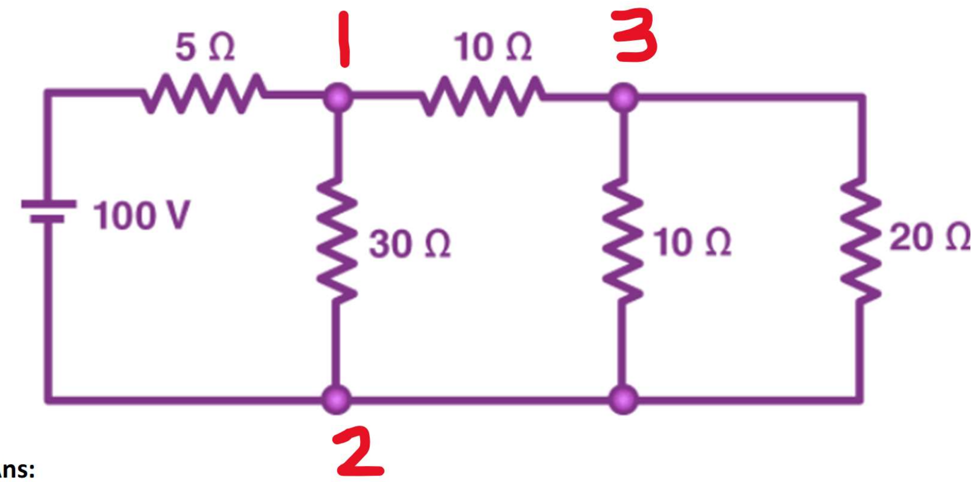
$15I1-5I2=V1$

$-5I1+10I2=0$

$3I2=10$

Solving these equations simultaneously we get V1= 83.33V.

Q6.



Ans:

Let node 2 be the reference node, and this node's voltage will be zero

Using Kirchhoff's current law at each node, we get

$$\frac{V_1}{30} + \frac{V_1 - 100}{5} + \frac{V_1 - V_3}{10} = 0$$

(eq.1)

This is a result of KCL at node 1

$$\frac{V_3 - V_1}{10} + \frac{V_3}{10} + \frac{V_3}{20} = 0$$

(eq.2)

This is a result of KCL at node 3

$$\left(\frac{1}{30} + \frac{1}{5} + \frac{1}{10}\right)V_1 - \left(\frac{1}{10}\right)V_3 = \frac{100}{5}$$
$$-\left(\frac{1}{10}\right)V_1 + \left(\frac{1}{10} + \frac{1}{10} + \frac{1}{20}\right)V_3 = 0$$

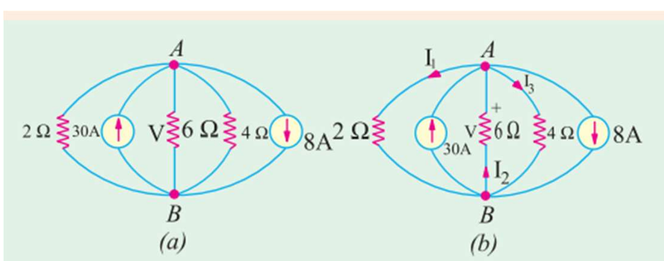
Solving the above equations we get

V_1 = 68.2v

V_3 = 27.3v

Assignment for H.W.

Q. 1Using Kirchhoff's Current Law and Ohm's Law, find the magnitude and polarity of voltge V in Fig. 2.9 (a).Directions of the two current sources are as shown.



Solution. Let us arbitrarily choose the directions of I_1, I_2 and I_3 and polarity of V as shown in Fig. 2.9.(*b*). We will use the sign convention for currents as given in Art. 2.3. Applying KCL to node *A*, we have

$$-I_1 + 30 + I_2 - I_3 - 8 = 0$$

or $$I_1 - I_2 + I_3 = 22 \quad ...(i)$$

Applying Ohm's law to the three resistive branches in Fig. 2.9 (*b*), we have

$$I_1 = \frac{V}{2}, I_3 = \frac{V}{4}, I_2 = -\frac{V}{6} \qquad \text{(Please note the –ve sign.)}$$

Substituting these values in (*i*) above, we get

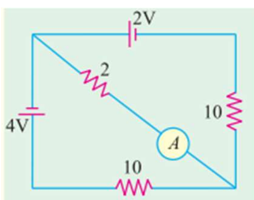
$$\frac{V}{2} - \left(\frac{-V}{6}\right) + \frac{V}{4} = 22 \quad \text{or} \quad V = \mathbf{24\ V}$$

$$\therefore \quad I_1 = V/2 = 24/2 = 12\text{ A}, I_2 = -24/6 = -4\text{ A}, I_3 = 24/4 = 6\text{ A}$$

The negative sign of I_2 indicates that actual direction of its flow is opposite to that shown in Fig. (*b*). Actually, I_2, flows from *A* to *B* and not from *B* to *A* as shown.

Incidentally, it may be noted that all currents are outgoing except 30A which is an incoming :ent.

Q. 2 Find the ammeter current in Fig. by using loop analysis



Ans: 1.7 A

<u>MCQs(Gate Question)</u>

<u>**1.**</u> Kirchhoff's Current Law (KCL) is based on the principle of:

a) Conservation of energy b) Conservation of momentum
c) Conservation of charge d) Conservation of mass

2. In a circuit, the sum of all voltages around a closed loop is zero. This statement is based on:

a) Ohm's Law b) Kirchhoff's Voltage Law (KVL)
c) Kirchhoff's Current Law (KCL) d) Norton's Theorem

3. What is the equivalent resistance of a network if a 12V battery produces a current of 3A through it?

a) 4Ω b) 6Ω c) 3Ω d) 2Ω

4. Kirchhoff's Voltage Law (KVL) is based on the principle of:

a) Conservation of charge
b) Conservation of energy
c) Conservation of momentum
d) Conservation of mass

5. Thevenin's Theorem states that any linear electrical network with voltage and current sources and resistances can be replaced at terminals A-B with:

a) A single current source and a parallel resistance
b) A single voltage source and a series resistance
c) A single resistance only
d) None of the above

6. To find the Thevenin equivalent voltage (Vth), you:

a) Short all voltage sources and open all current sources
b) Open all voltage sources and short all current sources
c) Measure the open-circuit voltage at the terminals
d) Measure the short-circuit current at the terminals

7. Norton's Theorem is used to:

a) Transform a network of voltage sources into a current source
b) Transform a network of current sources into a voltage source
c) Find the equivalent voltage and resistance
d) Find the equivalent current and resistance

8. In a parallel circuit, applying Kirchhoff's Current Law (KCL) at a node means:

a) Summing the voltages at the node to zero
b) Summing the currents entering and leaving the node to zero
c) Summing the resistances at the node to zero
d) Summing the power at the node to zero

9. To find the Norton equivalent current (In), you:

a) Short all voltage sources and open all current sources
b) Open all voltage sources and short all current sources
c) Measure the open-circuit voltage at the terminals
d) Measure the short-circuit current at the terminals

10. Which theorem states that a linear two-terminal circuit can be replaced by an equivalent circuit consisting of a current source in parallel with a resistor?

a) Thevenin's Theorem
b) Norton's Theorem
c) Superposition Theorem
d) Millman's Theorem

11. In applying Kirchhoff's Voltage Law (KVL) around a loop, we consider the sum of:

a) Voltages in any direction to be zero
b) Voltage drops to be zero
c) Voltage sources to be zero
d) Voltages around the loop to be zero

12. When determining the Thevenin equivalent resistance, the independent sources are:

a) Short-circuited for voltage sources and open-circuited for current sources
b) Open-circuited for voltage sources and short-circuited for current sources
c) Removed from the circuit
d) Not considered

13. Kirchhoff's Current Law (KCL) is applied to:

a) Closed loops in a circuit
b) Nodes in a circuit
c) Series resistances in a circuit
d) Parallel resistances in a circuit

14. For a given linear network, the Norton equivalent circuit consists of:

a) A voltage source in series with a resistor
b) A current source in parallel with a resistor
c) A voltage source in parallel with a resistor
d) A current source in series with a resistor

15. Thevenin's and Norton's Theorems are applicable to:

a) Non-linear circuits
b) Linear circuits
c) Both linear and non-linear circuits
d) AC circuits only

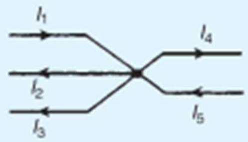


Figure 13.88

2. Which of the following statements is true? For the circuit shown in Fig. 13.89:
   (a) $E_1 + E_2 + E_3 = Ir_1 + Ir_2 + I_3r_3$
   (b) $E_2 + E_3 - E_1 - I(r_1 + r_2 + r_3) = 0$
   (c) $I(r_1 + r_2 + r_3) = E_1 - E_2 - E_3$
   (d) $E_2 + E_3 - E_1 = Ir_1 + Ir_2 + Ir_3$

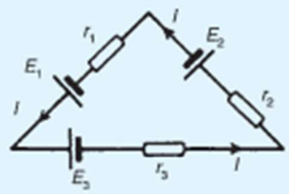


Figure 13.89

3. For the circuit shown in Fig. 13.90, the internal resistance r is given by:
   (a) $\dfrac{I}{V-E}$ (b) $\dfrac{V-E}{I}$
   (c) $\dfrac{I}{E-V}$ (d) $\dfrac{E-V}{I}$

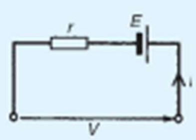


Figure 13.90

4. For the circuit shown in Fig. 13.91, voltage V is:
   (a) 12 V (b) 2 V (c) 10 V (d) 0 V

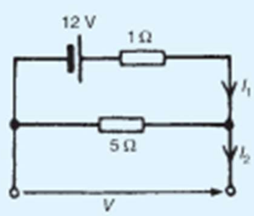


Figure 13.91

5. For the circuit shown in Fig. 13.91, current I_1 is:
   (a) 2 A (b) 14.4 A
   (c) 0.5 A (d) 0 A

6. For the circuit shown in Fig. 13.91, current I_2 is:
   (a) 2 A (b) 14.4 A
   (c) 0.5 A (d) 0 A

7. The equivalent resistance across terminals AB of Fig. 13.92 is:
   (a) 9.31 Ω (b) 7.24 Ω
   (c) 10.0 Ω (d) 6.75 Ω

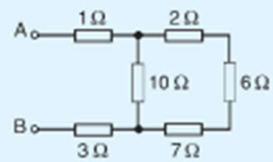


Figure 13.92

8. With reference to Fig. 13.93, which of the following statements is correct?
   (a) $V_{PQ} = 2\,V$
   (b) $V_{PQ} = 15\,V$
   (c) When a load is connected between P and Q, current would flow from Q to P
   (d) $V_{PQ} = 20\,V$

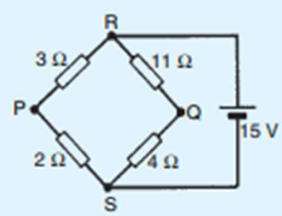


Figure 13.93

9. In Fig. 13.93, if the 15 V battery is replaced by a short-circuit, the equivalent resistance across terminals PQ is:
   (a) 20 Ω (b) 4.20 Ω
   (c) 4.13 Ω (d) 4.29 Ω

Ans: 2.(c); 3(b); 4(c); 5(a); 6(d); 7(c); 8(a); 9(c)