Tutorial Sheet-1 (Unit-1)

Q1. The total charge entering a terminal is given by q = 5t sin 4πt mC. Calculate the current at t = 0.5 s.

Ans. 1.

The total charge entering a terminal is given by $q = 5t \sin 4\pi t$ mC. Calculate the current at $t = 0.5$ s.

Solution:

$$i = \frac{dq}{dt} = \frac{d}{dt}(5t \sin 4\pi t) \text{ mC/s} = (5 \sin 4\pi t + 20\pi t \cos 4\pi t) \text{ mA}$$

At $t = 0.5$,

$$i = 5 \sin 2\pi + 10\pi \cos 2\pi = 0 + 10\pi = 31.42 \text{ mA}$$

Q2. Determine the total charge entering a terminal between t = 1 s and t = 2 s, if the current passing the terminal is $i = (3t^2 - t)$ A.

Ans 2:

Determine the total charge entering a terminal between $t = 1$ s and $t = 2$ s if the current passing the terminal is $i = (3t^2 - t)$ A.

Solution:

$$q = \int_{t=1}^{2} i\, dt = \int_{1}^{2} (3t^2 - t)\, dt$$

$$= \left(t^3 - \frac{t^2}{2}\right)\Big|_1^2 = (8 - 2) - \left(1 - \frac{1}{2}\right) = 5.5 \text{ C}$$

Q3. How much energy does a 100-W electric bulb consume in two hours?

Ans3:

$$\text{Energy (in watt-hours, Wh)} = \text{Power (in watts, W)} \times \text{Time (in hours, h)}$$

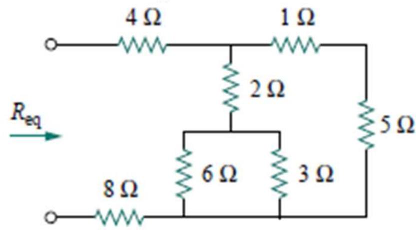
Given:

- Power = 100 W
- Time = 2 hours

$$\text{Energy} = 100\,\text{W} \times 2\,\text{h} = 200\,\text{Wh}$$

So, a 100-watt electric bulb consumes 200 watt-hours (Wh) or 0.2 kilowatt-hours (kWh) in two hours.

Q4. Find R_{eq} for the circuit shown in Fig.



Ans4: 14.4 Ω

To get R_{eq}, we combine resistors in series and in parallel. The 6-Ω and 3-Ω resistors are in parallel, so their equivalent resistance is

$$6\ \Omega \parallel 3\ \Omega = \frac{6 \times 3}{6+3} = 2\ \Omega$$

(The symbol $\parallel$ is used to indicate a parallel combination.) Also, the 1-Ω and 5-Ω resistors are in series; hence their equivalent resistance is

$$1\ \Omega + 5\ \Omega = 6\ \Omega$$

Thus the circuit in Fig. 2.34 is reduced to that in Fig. 2.35(a). In Fig. 2.35(a), we notice that the two 2-Ω resistors are in series, so the equivalent resistance is

$$2\ \Omega + 2\ \Omega = 4\ \Omega$$

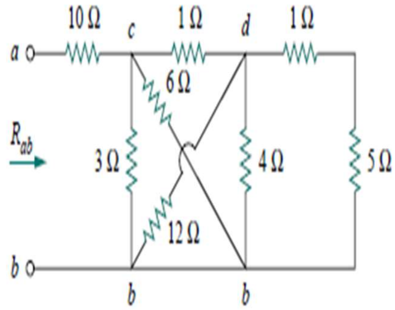
This 4-Ω resistor is now in parallel with the 6-Ω resistor in Fig. 2.35(a); their equivalent resistance is

$$4\ \Omega \parallel 6\ \Omega = \frac{4 \times 6}{4+6} = 2.4\ \Omega$$

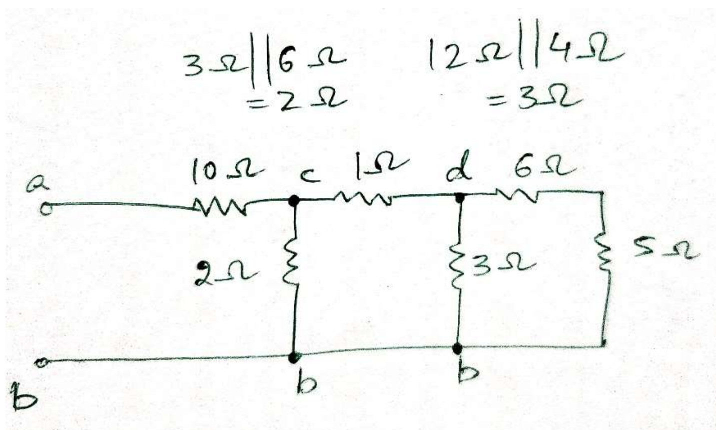
The circuit in Fig. 2.35(a) is now replaced with that in Fig. 2.35(b). In Fig. 2.35(b), the three resistors are in series. Hence, the equivalent resistance for the circuit is

$$R_{eq} = 4\ \Omega + 2.4\ \Omega + 8\ \Omega = 14.4\ \Omega$$

Q5. Calculate the equivalent resistance R_{ab} in the circuit in Fig.



Ans 5: 11.2 Ω



The 3-Ω and 6-Ω resistors are in parallel because they are connected to the same two nodes c and b. Their combined resistance is

$$3\ \Omega \parallel 6\ \Omega = \frac{3 \times 6}{3+6} = 2\ \Omega \tag{2.10.1}$$

Similarly, the 12-Ω and 4-Ω resistors are in parallel since they are connected to the same two nodes d and b. Hence

$$12\ \Omega \parallel 4\ \Omega = \frac{12 \times 4}{12+4} = 3\ \Omega \tag{2.10.2}$$

Also the 1-Ω and 5-Ω resistors are in series; hence, their equivalent resistance is

$$1\ \Omega + 5\ \Omega = 6\ \Omega \tag{2.10.3}$$

With these three combinations, we can replace the circuit in Fig. 2.37 with that in Fig. 2.38(a). In Fig. 2.38(a), 3-Ω in parallel with 6-Ω gives 2-Ω, as calculated in Eq. (2.10.1). This 2-Ω equivalent resistance is now in series with the 1-Ω resistance to give a combined resistance of $1\ \Omega + 2\ \Omega = 3\ \Omega$. Thus, we replace the circuit in Fig. 2.38(a) with that in Fig. 2.38(b). In Fig. 2.38(b), we combine the 2-Ω and 3-Ω resistors in parallel to get

$$2\ \Omega \parallel 3\ \Omega = \frac{2 \times 3}{2+3} = 1.2\ \Omega$$

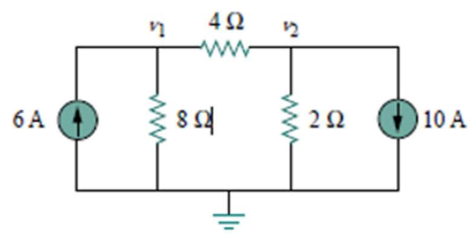
This 1.2-Ω resistor is in series with the 10-Ω resistor, so that

$$R_{ab} = 10 + 1.2 = 11.2\ \Omega$$

Practice Problem for H.W.

Q1.

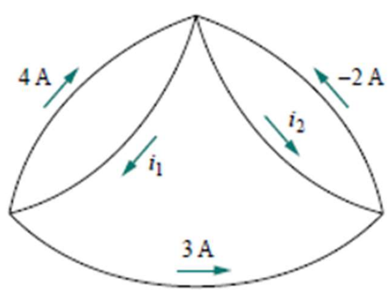
Determine v_1, v_2, and the power dissipated in all the resistors in the circuit of Fig.



Ans: V_1=22.85 V and V_2= -10.28 V.

Q2.

Determine i_1 and i_2 in the circuit in Fig.



Ans: I_1= 7A and I_2= -5Amp.

<u>MCQ: Unit-1(Gate Question)</u>

1. The current through a 2Ω resistor is 3A. What is the voltage across the resistor?

a) 6V b) 2V c) 1.5V d) 0.67V

2. Which of the following is true for a series circuit?

a) The current is the same through all components.
b) The voltage is the same across all components.
c) Both current and voltage are the same across all components.
d) None of the above.

3. What is the equivalent resistance of three resistors of 3Ω, 6Ω, and 9Ω connected in series?

a) 18Ω b) 1.8Ω c) 2Ω d) 6Ω

4. In a parallel circuit with resistors of 2Ω and 4Ω, what is the total resistance?

a) 6Ω b) 2.67Ω c) 1.33Ω d) 8Ω

5. In a DC circuit, power is dissipated as heat in a resistor. This power is given by:

a) $P = I^2R$ b) $P = V^2/R$
c) $P = VI$ d) All of the above

6. The voltage drop across a resistor in a DC circuit can be calculated using:

a) Ohm's Law b) Kirchhoff's Voltage Law
c) Both a and b d) Neither a nor b

7. A battery of 12V is connected to a resistor of 3Ω. The current flowing through the resistor is:

a) 36A b) 4A c) 3A d) 12A

8. Which of the following can be used to measure the resistance of a component in a DC circuit?

a) Voltmeter b) Ammeter c) Ohmmeter d) Wattmeter

9. Kirchhoff's current law is applicable to only
(*a*) closed loops in a network (*b*) electronic circuits (*c*) junctions in a network (*d*) electric circuits.

Ans: c
10. Kirchhoff's voltage law is concerned with
(*a*) *IR* drops (*b*) battery e.m.fs. (*c*) junction voltages (*d*) both (*a*) and (*b*)

Ans: d

11. According to *KVL*, the *algebraic* sum of all *IR* drops and e.m.f.s in any closed loop of a network is always
(*a*) zero (*b*) positive (*c*) negative (*d*) determined by battery e.m.fs.

12. The ***algebraic*** sign of an *IR* drop is primarily dependent upon the
(*a*) amount of current flowing through it (*b*) value of *R*
(*c*) direction of current flow (*d*) battery connection.

13. Point out the WRONG statement. In the node-voltage technique of solving networks, choice of a reference node does not
(*a*) affect the operation of the circuit
(*b*) change the voltage across any element
(*c*) alter the p.d. between any pair of nodes
(*d*) affect the voltages of various nodes.

14. Which of the following statements is true for the circuit shown in Fig:

a) $E_1 + E_2 + E_3 = Ir_1 + Ir_2 + I_3 r_3$
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) $E_2 + E_3 - E_1 = Ir_1 - Ir_2 + Ir_3$