①

BASICS OF ELECTRIC NETWORK

The tutorial is useful to understand basics of electrical networks.

Resistor :-

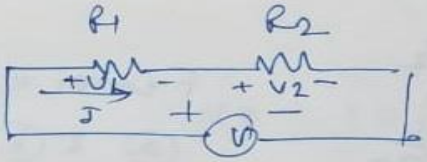
l = length, a = Area of crossection

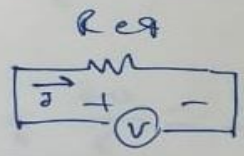
$$R = \rho \frac{l}{a} \ \Omega$$

where ρ is resistivity in $\Omega - m$

Series circuit :-

Current through all elements remains same but voltage is divided. voltage division rule is applicable to series circuit.





APPLY KVL

$$V = V1 + V2$$

$$V = IR1 + IR2$$

$$\frac{V}{I} = R1 + R2 \quad \text{—①}$$

$$V = IReq \quad \text{—②}$$

From eq^n ① & ②

$$\boxed{Req = R1 + R2 \ \Omega}$$

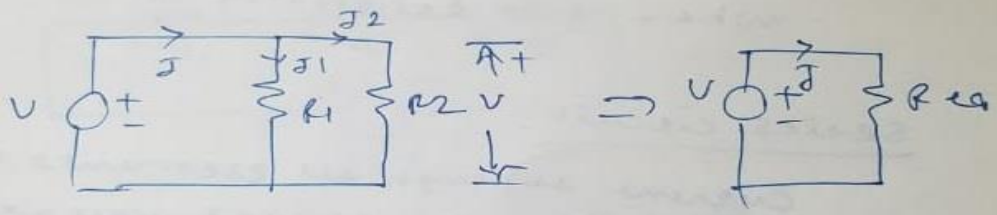
Use voltage divider rule

$V_1 = I R_1$ $\qquad$ $V_2 = I R_2$

$$V_1 = \frac{V}{R_1+R_2} R_1 \qquad V_2 = \frac{V}{R_1+R_2} R_2$$

Parallel circuit:

current is divided & voltage across each element remains same. The current-division rule is applicable.



APPLY KCL

$$I = I_1 + I_2$$

$$= \frac{V}{R_1} + \frac{V}{R_2}$$

$$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$G_{eq} = G_1 + G_2$$

G_1 = conductance = $\frac{1}{R_1}$

G_2 = conductance = $\frac{1}{R_2}$

$$V = I\left(\frac{R_1 R_2}{R_1+R_2}\right) \quad -(a)$$

$$V = I R_{eq} \quad -(b)$$

From equation (a) & (b)

$$R_{eq} = \frac{R_1 R_2}{R_1+R_2}$$

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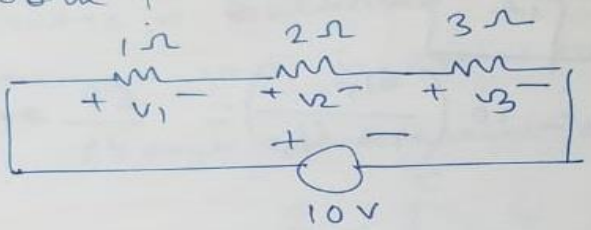
Use current division rule for two resistors connected in parallel.

$$I_1 = \frac{V}{R_1} = \frac{\left(I \frac{R_1 R_2}{R_1+R_2}\right)}{R_1} = I \frac{R_2}{R_1+R_2} \text{ Amp}$$

$$I_2 = \frac{V}{R_2} = \frac{\left(I \frac{R_1 R_2}{R_1+R_2}\right)}{R_2} = I \frac{R_1}{R_1+R_2} \text{ Amp}$$

Exercise : Find V_1, V_2, V_3 for following network ?



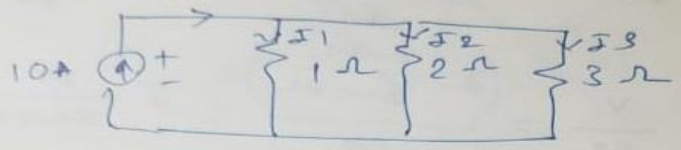
Apply voltage division rule

$$V_1 = 10\left(\frac{1}{1+2+3}\right) = \frac{10}{6} \text{ volts}$$

$$V_2 = 10\left(\frac{2}{1+2+3}\right) = \frac{20}{6} = \frac{10}{3} \text{ volts}$$

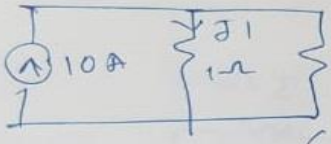
$$V_3 = 10\left(\frac{3}{1+2+3}\right) = \frac{30}{6} = 5 \text{ volts}$$

Exercise II : Find I_1, I_2, I_3 for following circuit $I = 10A$



Use current division rule

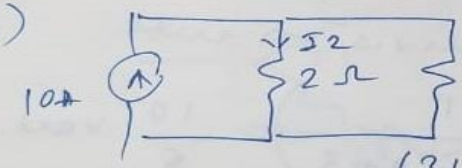
a)



$2 \| 3 = \frac{6}{5}\ \Omega$

$$I_1 = 10\left(\frac{6/5}{1 + 6/5}\right) = \frac{60}{11}\ \text{Amp}$$

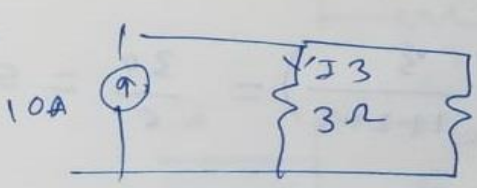
b)



$1 \| 3 = \frac{3}{4}\ \Omega$

$$I_2 = 10\left(\frac{3/4}{2 + 3/4}\right) = \frac{30}{11}\ \text{Amp}$$

c)



$1 \| 2 = \frac{2}{3}\ \Omega$

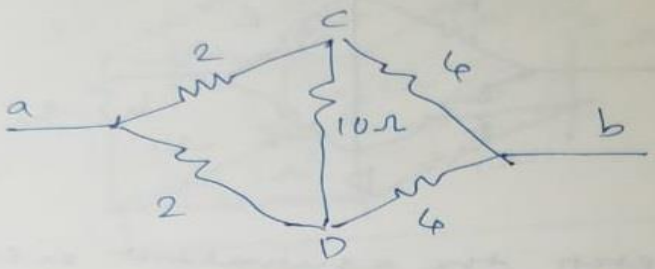
$$I_3 = 10\left(\frac{2/3}{3 + 2/3}\right) = \frac{20}{11}\ \text{Amp}$$

Note : current division rule is applicable to two resistors connected in parallel

(3)

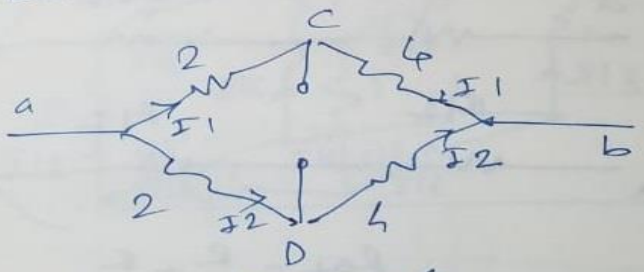
→ Let us find the equivalent resistor seen from terminal a, b

a)

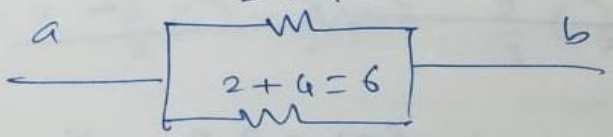


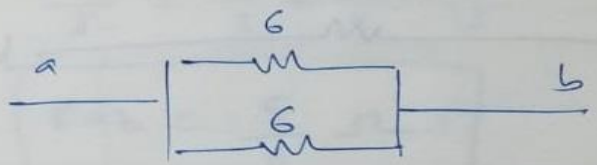
Now as ratio of $\frac{2}{2} = \frac{4}{4}$ the bridge is balanced. Therefore current through 10Ω is equal to zero.

Sketch equivalent circuit



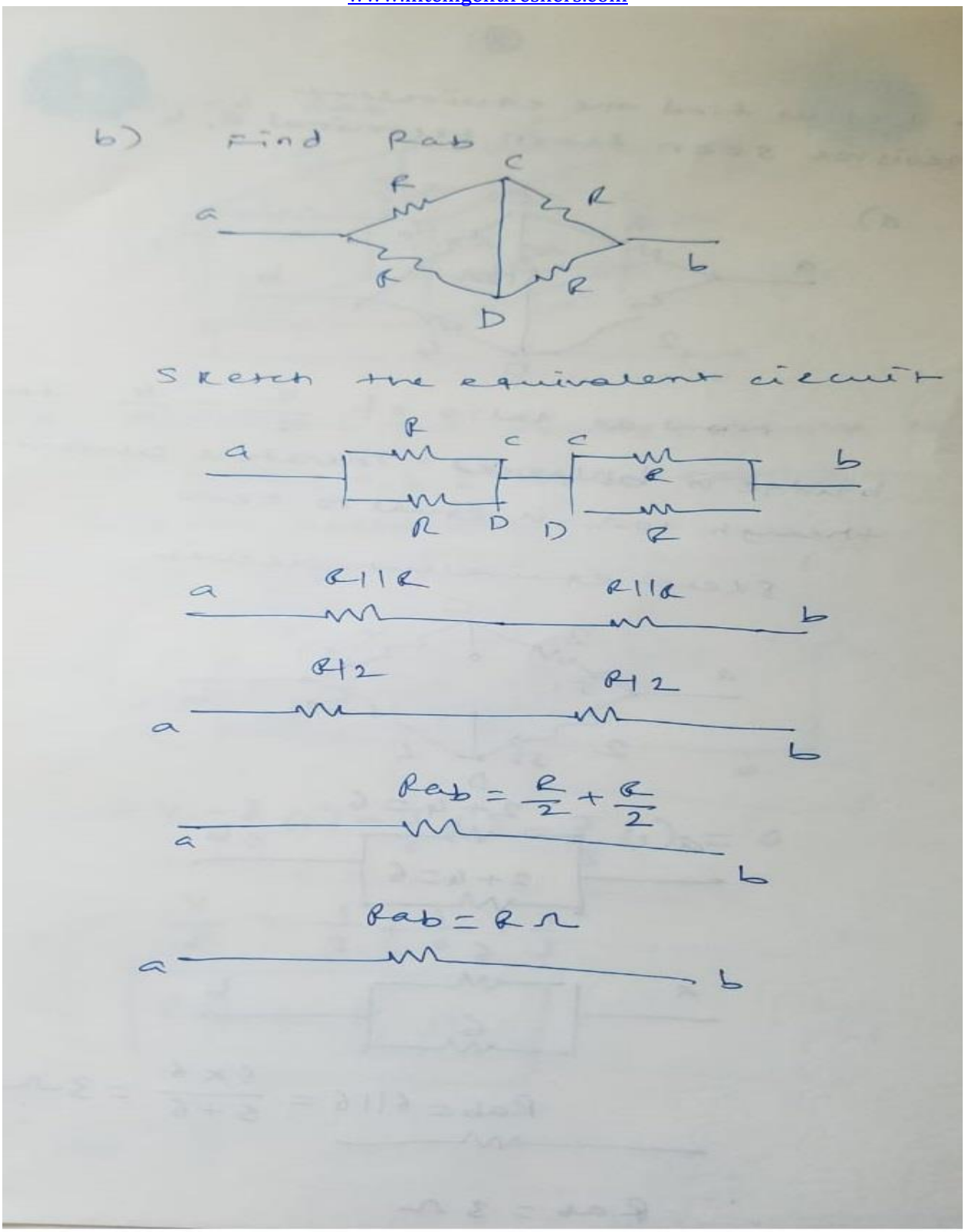
$2 + 4 = 6$





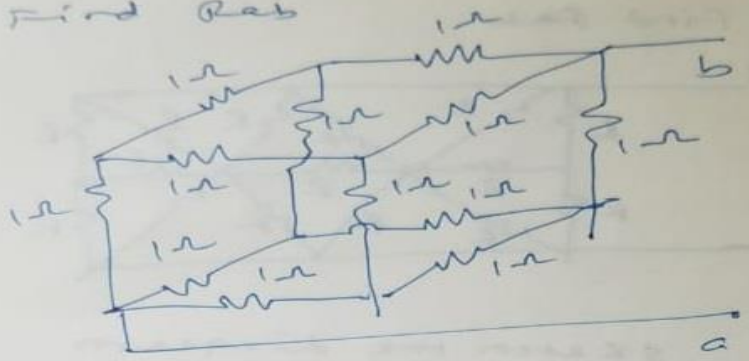
$R_{ab} = 6 \| 6 = \frac{6 \times 6}{6+6} = 3\Omega$

$\therefore R_{ab} = 3\Omega$

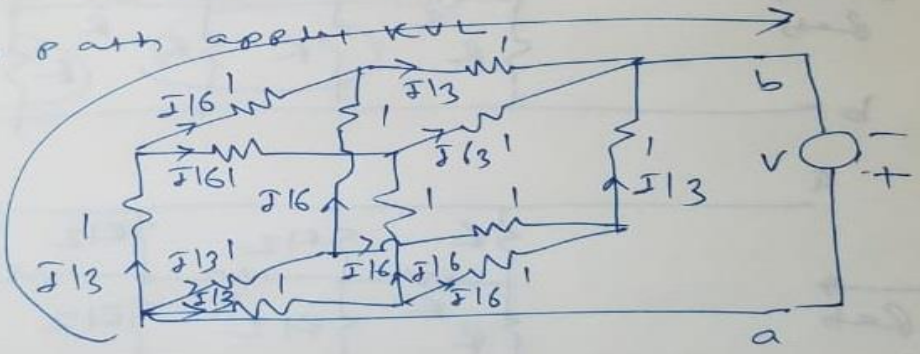

b) Find Rab
C
R
R
a
b
R
R
D
Sketch the equivalent circuit
R
C
C
a
b
R
D
D
R
R||R
R||R
a
b
R/2
R/2
a
b
Rab = R/2 + R/2
a
b
Rab = R Ω
a
b

(4)

c) Find Rab



→ Connect the voltage source ob V across a, b & then from a to b path apply KVL

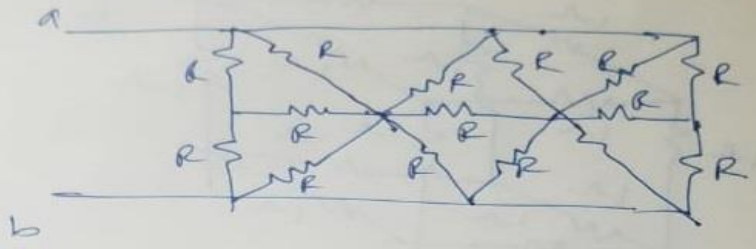


$$+V - \frac{J}{3}(1) - \frac{J}{6}(1) - \frac{J}{3}(1) = 0$$

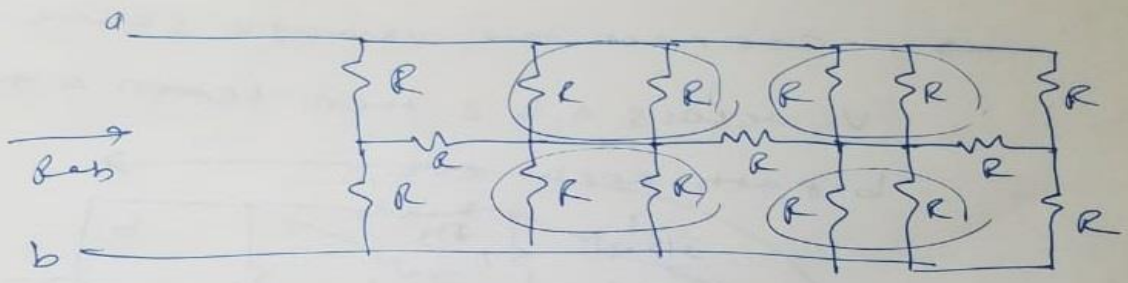
$$\frac{V}{J} = \frac{1}{3} + \frac{1}{6} + \frac{1}{3}$$

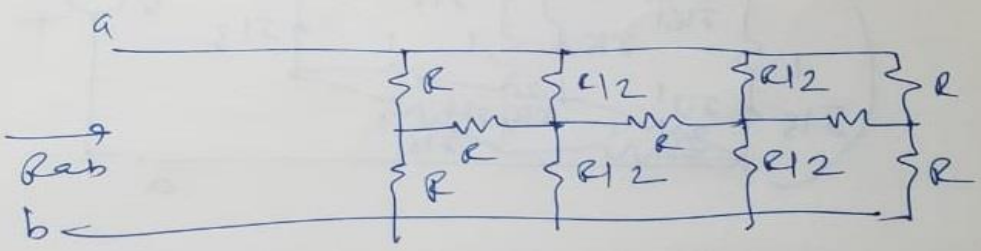
$$\boxed{Rab = \frac{5}{6}\ \Omega}$$

d) Find Rab

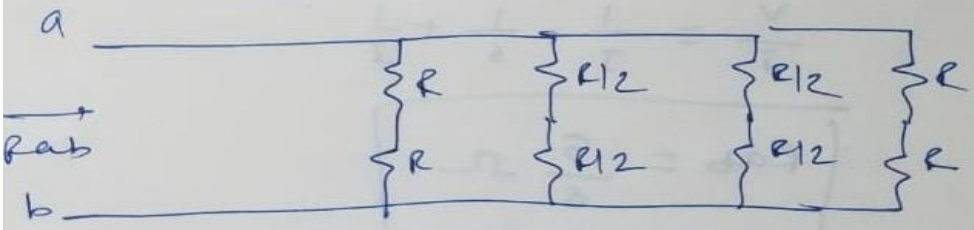


→ sketch the diagram





From above network it is clear that we have balance bridge



$$\frac{1}{R_{ab}} = \frac{1}{2R} + \frac{1}{R} + \frac{1}{R} + \frac{1}{2R} = \frac{3}{R}$$

$$R_{ab} = R/3\ \Omega$$