BME 301

4-Simple Circuits

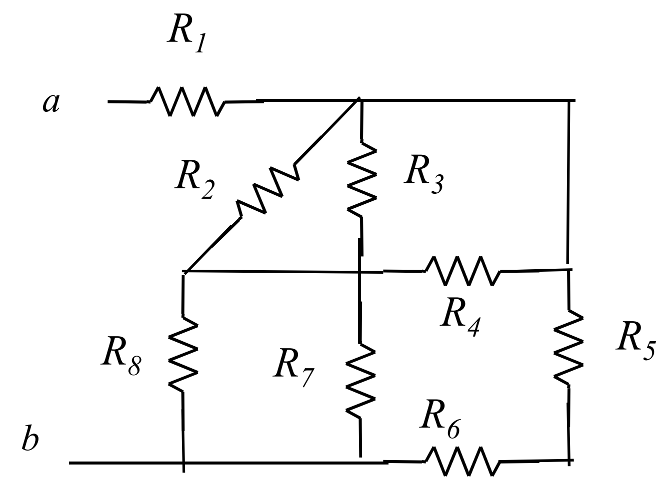
Homework

1. Find the total resistance R_{ab} where

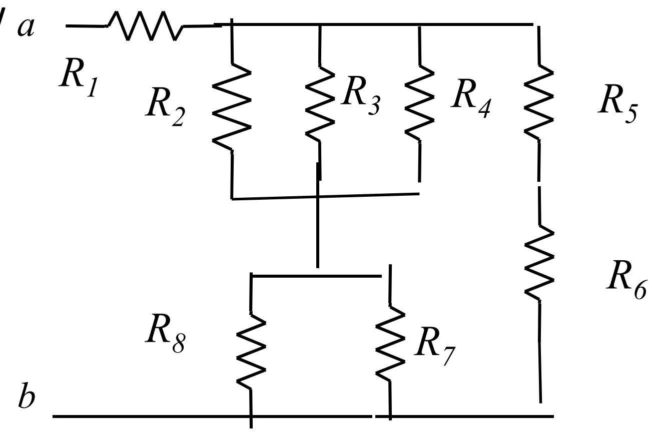
$R_1 = 10\Omega$, $R_2 = 15\Omega$, $R_3 = 15\Omega$,

$R_4 = 15\Omega$, $R_5 = 10\Omega$, $R_6 = 10\Omega$,

$R_7 = 10\Omega$, $R_8 = 10\Omega$



In this circuit R5 and R6 are in series. In addition, R4, R3, and R2 are in parallel. Finally R7 and R8 are in parallel. These two parallel combinations are in series. This series combination is in series with the series combination of R5 and R6. R1 is in series with this parallel combinations. This is the circuit redrawn. See the follow page for another method.



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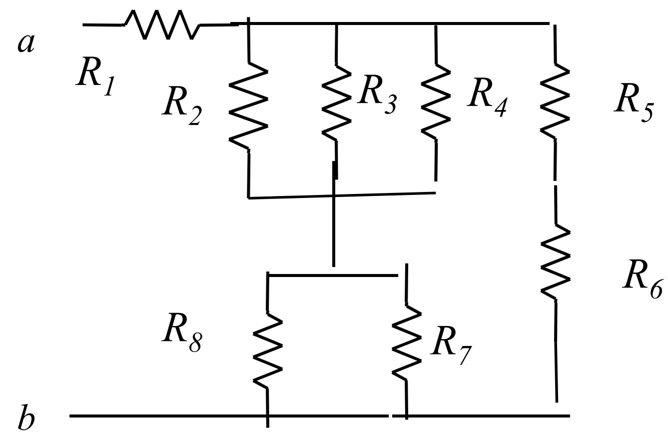


RA=R5 in series with R6 = 10 + 10 = 20 Ω

$$RB = R4, R3 \text{ and } R2 \text{ in parallel} = \frac{1}{\frac{1}{15}+\frac{1}{15}+\frac{1}{15}} = \frac{1}{\frac{3}{15}} = \frac{15}{3} = 5\Omega$$

$$RC = R7 \text{ in parallel with } R8 = \frac{1}{\frac{1}{10}+\frac{1}{10}} = \frac{1}{\frac{2}{10}} = 5\Omega$$

RD=RB in series with RC=5+5=10Ω

$$RE = RD \text{ in paralled with } RA = \frac{1}{\frac{1}{10}+\frac{1}{20}} = \frac{20}{3} = 6.67\Omega$$

R1 in series with RE=10 + 6.67 = 16.67Ω

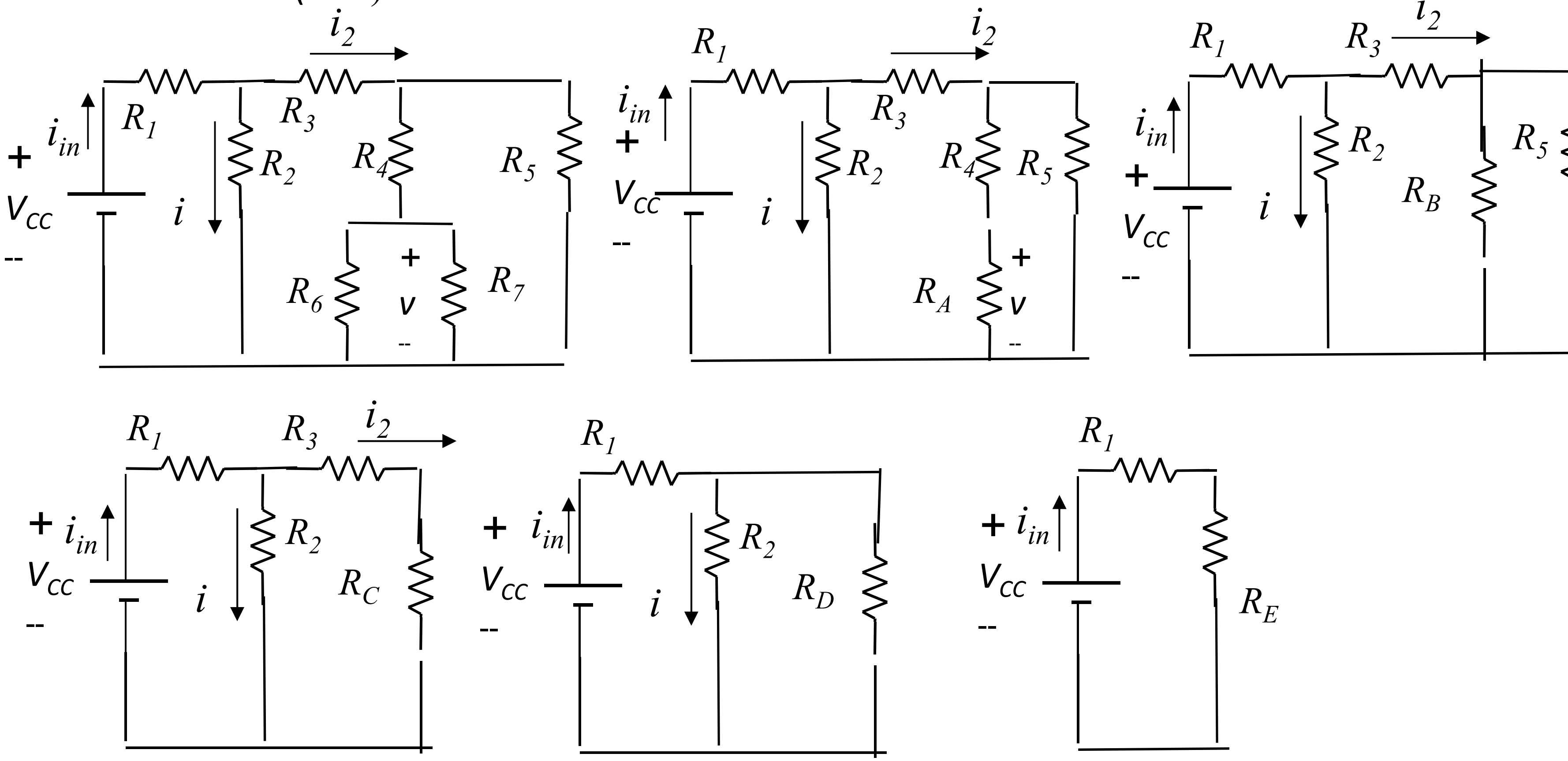
Homework

2. Calculate the current labeled, *i.*

$R_1 = 2.5\Omega$, $R_2 = 5\Omega$, $R_3 = 2.5\Omega$, $R_4 = 2.5\Omega$, $R_5 = 5\Omega$,

$R_6 = 5\Omega$, $R_7 = 5\Omega$, $V_{cc} = 5$

R6 and R7 are in parallel (Call it RA=2.5Ω). RA is in series with R4 (call is RB=5Ω). RB is in parallel with R5 (Call it RC=2.5Ω). RC is in series with R3 (Call it RD=5Ω).RD is in parallel with R2 (Call it RE=2.5Ω). RE is in series with R1 (=5Ω).



Homework

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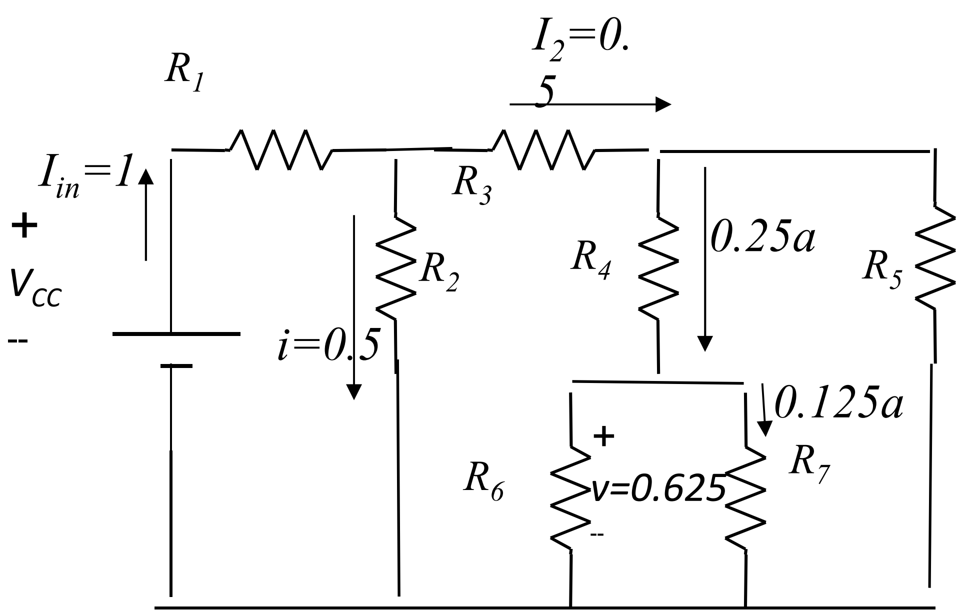
$R_6 = 5\Omega$, $R_7 = 5\Omega$, $V_{cc} = 5$

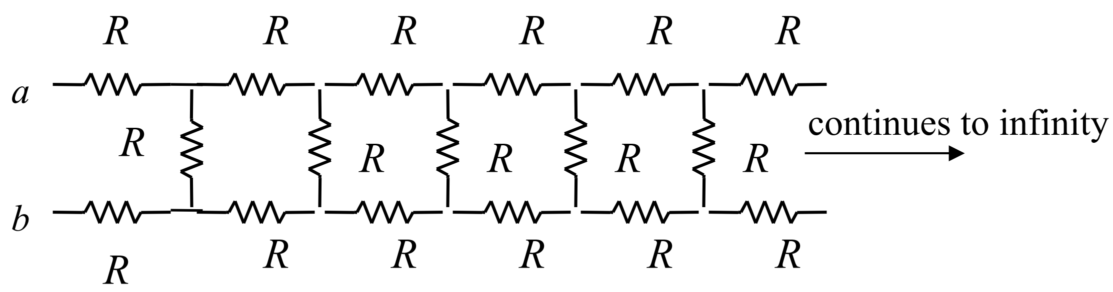
Now i_{in}= 5/5=1. Then using current division i= 1/2 =0.5 since RD=R2. And therefore, i_2=0.5. Then the current flowing into RB=0.25 since RB=R5. Since R6=R7, Then the current R7 = 0.125 and the voltage labeled v=0.125X5=0.625 volt or v=0.5X1.5=0.625.



Homework

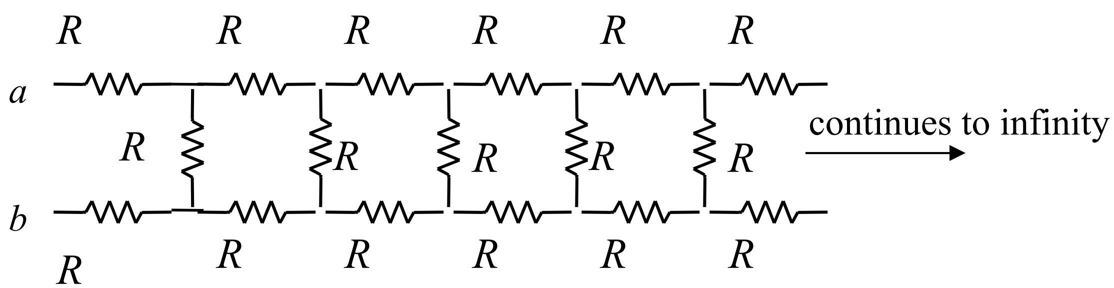
3. HONORS STUDENTS ADD THE FOLLOWING

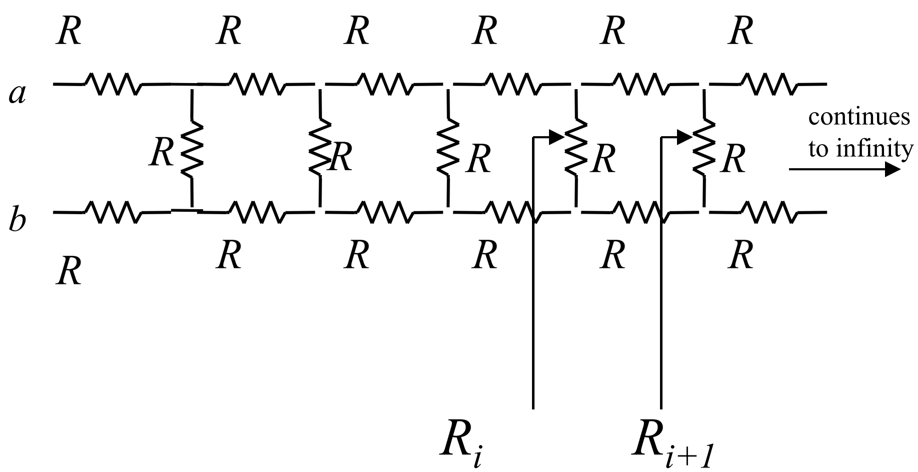
Find the total resistance R_{ab} for this infinite resistive network.



Homework

Find the total resistance R_{ab} for this infinite resistive network





METHOD #1 Theoretical

$$R_i = (R_{i+1} + 2R) \parallel R = \frac{(R_{i+1} + 2R)R}{R_{i+1} + 3R}$$

But since the chain is infinite, shouldn't $R_i = R_{i+1} = r$

$$r = \frac{(r + 2R)R}{r + 3R} \Rightarrow r^2 + 3Rr = Rr + 2R^2 \Rightarrow r^2 + 2Rr - 2R^2 = 0$$

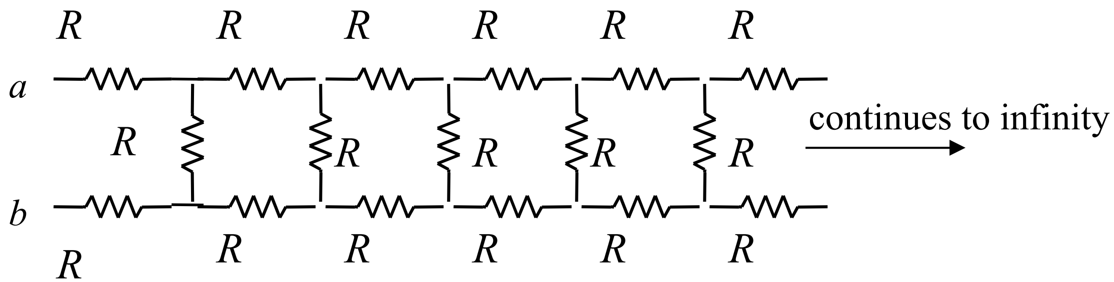
$$r = \frac{-2R \pm \sqrt{(2R)^2 - 4(-2R^2)}}{2} = \frac{-2R \pm R\sqrt{4+8}}{2} = \frac{-2R \pm R2\sqrt{3}}{2}$$

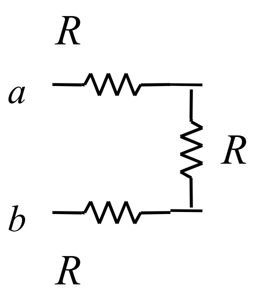
$$r = R(\sqrt{3} - 1)$$

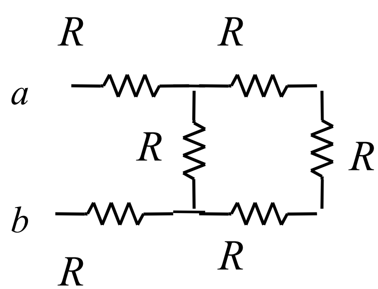
$$R_{ab} = 2R + r = (1 + \sqrt{3})R = 2.732R$$

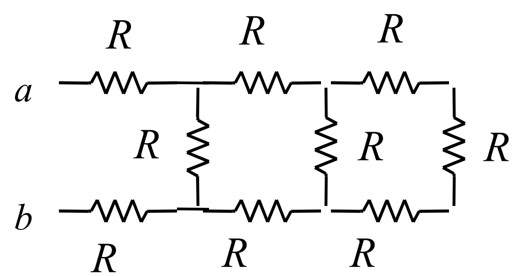
Homework

Find the total resistance R_{ab} for this infinite resistive network









METHOD #2

Numerical Iteration

Iteration 1

$$R_{ab}^{1} = 3R$$

Iteration 2

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

$$R_{ab}^{2} = 2R + \frac{R(3R)}{4R} = 2R + .75R = 2.75R$$

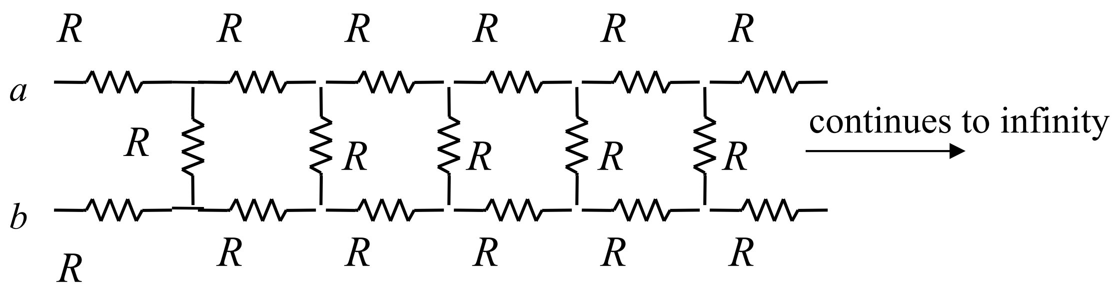
Iteration 3

$$R_{ab}^{3} = 2R + R \parallel (2R + R \parallel 3R) = 2R + R \parallel (R_{ab}^{2})$$

$$R_{ab}^{3} = 2R + \frac{R(2.75R)}{R + (2.75R)} = 2R + \frac{2.75R}{3.75} = 2R + .733R = 2.733R$$

Homework

Find the total resistance R_{ab} for this infinite resistive network



Iteration	Rab
1	3
2	2.75
3	2.733333
4	2.732143
5	2.732057
6	2.732051
7	2.732051
8	2.732051
9	2.732051
10	2.732051
11	2.732051
12	2.732051
13	2.732051
14	2.732051
15	2.732051
16	2.732051
17	2.732051
18	2.732051
19	2.732051
20	2.732051

Iteration N

$$R_{ab}^{N} = 2R + R \,||\, R_{ab}^{N-1}$$

Continuing this way we see that R_{ab} approaches 2.732R where 2.732 is the sqrt(3)+1