EE301/303 Spog HW2 Solution

Problem 1

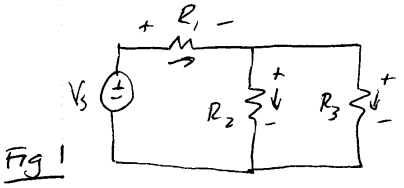


Fig 1

Given: $V_s = 30V$, $R_1 = R_2 = R_3 = 500\Omega$

Find: R_{eq}
i_{VS}
i_{R1}, i_{R2}, i_{R3}
V_{R1}, V_{R2}, V_{R3}

$$R_{23} = R_2 /\!/ R_3 = \frac{1}{\frac{1}{500}+\frac{1}{500}} = 250\Omega$$

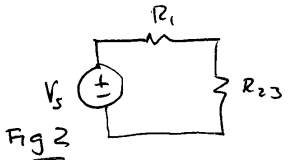


Fig 2

$$R_{eq} = R_{123} = R_1 + R_{23} = 500+250 = \underline{750\Omega = R_{eq}}$$

$$i_{VS} = \frac{V_s}{R_{eq}} = \frac{30}{750}$$

$$\underline{i_{VS} = 0.04A = 40mA} \leftarrow$$

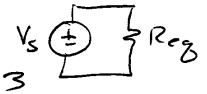


Fig 3

Using Fig 2: $V_{R1} = \frac{R_1}{R_1+R_{23}} \cdot V_s = \frac{500}{500+250} \cdot 30$

$$\underline{V_{R1} = 20V} \leftarrow$$

$$V_{R23} = \frac{R_{23}}{R_1+R_{23}} \cdot V_s = \frac{250}{500+250} \cdot 30$$

$$V_{R23} = 10V$$

$$i_{R1} = i_{R23} = i_{VS}$$

$$\underline{i_{R1} = 40mA} \leftarrow$$

Using Fig 3: $V_{R2} = V_{R3} = V_{R23} = 10V \rightarrow \underline{V_{R2} = 10V} \leftarrow$

$$\underline{V_{R3} = 10V} \leftarrow$$

$$i_{R2} = \frac{\frac{1}{R_2}}{\frac{1}{R_2}+\frac{1}{R_3}} \cdot i_{R1} = \frac{R_3}{R_2+R_3} \cdot i_{R1}$$

$$= \frac{500}{500+500} \cdot 40mA$$

$$\underline{i_{R2} = 20mA}$$

$$i_{R3} = \frac{\frac{1}{R_3}}{\frac{1}{R_2}+\frac{1}{R_3}} \cdot i_{R1} = \frac{R_2}{R_2+R_3} \cdot i_{R1}$$

$$= \frac{500}{500+500} \cdot 40mA$$

$$\underline{i_{R3} = 20mA} \leftarrow$$

EE301/303 SP09 HW2 SOLUTION

PROBLEM 2

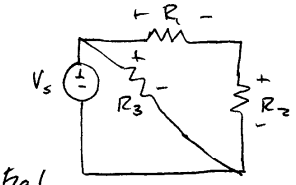


Fig 1

GIVEN: $V_s = 30V$, $R_1 = 100\Omega$
$R_2 = 200\Omega$, $R_3 = 300\Omega$

FIND: • R_{eq}
• i_{VS}
• i_{R1}, i_{R2}, i_{R3}
V_{R1}, V_{R2}, V_{R3}

$R_1 + R_2 = R_{12} = 100 + 200$
$R_{12} = 300$

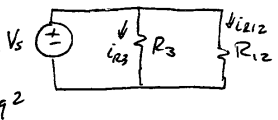


Fig 2

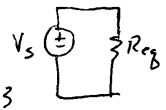


Fig 3

$R_{123} = R_{eq} = R_{12} \,//\, R_3 = \frac{1}{\frac{1}{300}+\frac{1}{300}} = 150\Omega$

$i_{VS} = \frac{V_s}{R_{eq}} = \frac{30}{150} = 0.2A = 200mA = i_{VS}$

From Fig. 2 $V_s = V_{R3} = 30V$ ←
$V_{R12} = V_s = 30V$

$i_{R3} = \frac{\frac{1}{R_3}}{\frac{1}{R_3}+\frac{1}{R_{12}}} \cdot i_{VS} = \frac{\frac{1}{300}}{\frac{1}{300}+\frac{1}{300}} \cdot 200mA = 100mA = i_{R3}$ ←

$i_{R12} = \frac{\frac{1}{R_{12}}}{\frac{1}{R_3}+\frac{1}{R_{12}}} \cdot i_{VS} = \frac{\frac{1}{300}}{\frac{1}{300}+\frac{1}{300}} \cdot 200mA = 100mA = i_{R12}$

From Fig 1
$i_{R1} = i_{R2} = i_{R12} \Rightarrow i_{R1} = 100mA$ ←
$i_{R2} = 100mA$ ←

$V_{R1} = \frac{R_1}{R_1+R_2} \cdot V_{R12} = \frac{100}{100+200} \cdot 30 = 10V = V_{R1}$ ←

$V_{R2} = \frac{R_2}{R_1+R_2} \cdot V_{R12} = \frac{200}{100+200} \cdot 30 = 20V = V_{R2}$ ←

EE301/303 SP09 HW 2 SOLUTION

PROBLEM 3

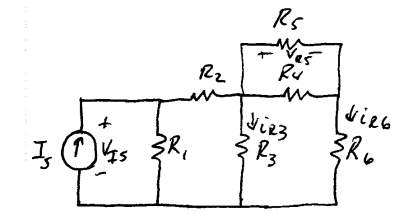


Fig 1

$R_{45} = R_4 // R_5 = \frac{1}{\frac{1}{20}+\frac{1}{20}} = 10\Omega$

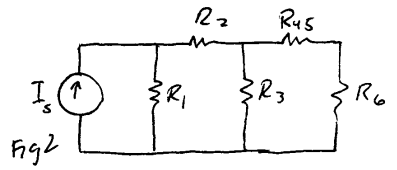


Fig 2

$R_{456} = R_6 + R_{45} =$

$R_{456} = 30 + 10 = 40\Omega$

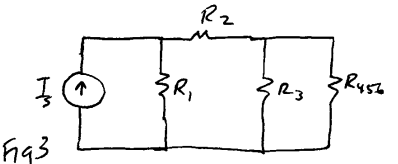


Fig 3

$R_{3456} = R_3 // R_{456} = \frac{1}{\frac{1}{20}+\frac{1}{40}}$

$R_{3456} = 13\frac{1}{3}\ \Omega$

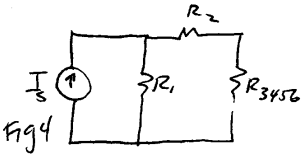


Fig 4

$R_{2\to6} = R_2 + R_{3456} =$

$= 10 + 13\frac{1}{3} = 23\frac{1}{3}\Omega$

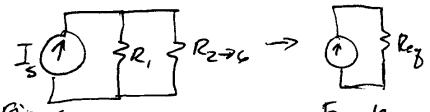


Fig. 5 Fig. 6

GIVEN: $R_1 = 20\Omega$, $R_2 = 10\Omega$

$R_3 = R_4 = R_5 = 20\Omega$

$R_6 = 30\Omega$

$I_S = 5A$

FIND: • R_{eq}

• i_{R3}, i_{R4}

• V_{R5}, V_{IS}

From Fig. 6 $V_{IS} = I_S R_{eq}$

$= 5(10.77)$

$V_{IS} = 53.85V$ ←

From Fig 5: $V_{R1} = V_{R2\to6} = V_{IS} = 53.85V$

$i_{R2\to6} = \frac{\frac{1}{R_{2\to6}}}{\frac{1}{R_{2\to6}}+\frac{1}{R_1}} \cdot I_S = \frac{\frac{1}{23.\bar{3}}}{\frac{1}{23.\bar{3}}+\frac{1}{20}} \cdot I_S$

$i_{R2\to6} = 2.31A$

From Fig 4: $i_{R2} = i_{R3\to6} = i_{R2\to6} = 2.31A$

$V_{R3456} = \frac{R_{3456}}{R_2 + R_{3456}} \cdot V_{R2\to6}$

$= \frac{13.\bar{3}}{10+13.3} \cdot 53.85$

$V_{R3456} = 30.77\ V$

CONT. ON NEXT PAGE.

$R_{eq} = R_1 // R_{2\to6}$

$= \frac{1}{\frac{1}{20}+\frac{1}{23\frac{1}{3}}} = 10.77\Omega = R_{eq}$

Problem 3 cont.

From Fig. 3

$$V_{R3} = V_{R456} = V_{R3456} = 30.77\,V$$

$$i_{R3} = \frac{\frac{1}{R_3}}{\frac{1}{R_3} + \frac{1}{R_{456}}} \cdot i_{R3\to 6}$$

$$= \frac{\frac{1}{20}}{\frac{1}{20} + \frac{1}{40}} \cdot 2.31$$

$$\underline{i_{R3} = 1.54\,A} \leftarrow$$

$$i_{R456} = \frac{\frac{1}{R_{456}}}{\frac{1}{R_3} + \frac{1}{R_{456}}} \cdot i_{R3\to 6}$$

$$= \frac{\frac{1}{40}}{\frac{1}{20} + \frac{1}{40}} \cdot 2.31$$

$$i_{R456} = 0.77\,A$$

From Fig 2 $i_{R45} = i_{R6} = i_{R456}$

$$\underline{i_{R6} = 0.77\,A} \leftarrow$$

$$V_{R45} = \frac{R_{45}}{R_{45} + R_6} \cdot V_{R456}$$

$$= \frac{10}{10 + 30} \cdot 30.77$$

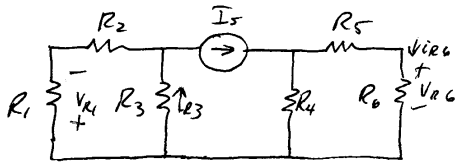
$$V_{R45} = 7.69\,V$$

From Fig. 1 $V_{R4} = V_{R5} = V_{1245}$

$$\underline{V_{R5} = 7.69\,V} \leftarrow$$

EE301/803 SP09 HW2 SOLUTION

PROBLEM 4

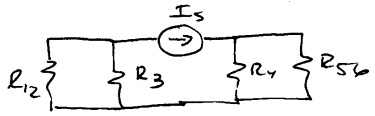


GIVEN: $R_1 = 15\Omega$, $R_2 = 15\Omega$
$R_3 = 30\Omega$, $R_4 = 40\Omega$
$R_5 = 20\Omega$, $R_6 = 20\Omega$
$I_s = 100\,mA$

FIND $i_{R3}, i_{R6}, v_{R1}, v_{R6}$

$R_{12} = R_1 + R_2 = 15 + 15 = 30\Omega$

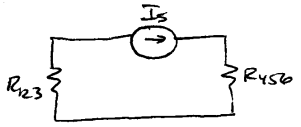
$R_{56} = R_5 + R_6 = 20 + 20 = 40\Omega$



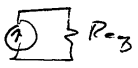
$$R_{123} = R_{12} \,//\, R_3 = \frac{1}{\frac{1}{R_{12}} + \frac{1}{R_3}} = \frac{1}{\frac{1}{30} + \frac{1}{30}}$$

$R_{123} = 15\Omega$

$$R_{456} = R_4 \,//\, R_{56} = \frac{1}{\frac{1}{40} + \frac{1}{40}} = 20\Omega$$



$R_{eq} = R_{123} + R_{456} = 15 + 20 = 35\Omega$



$V_{IS} = I_s R_{eq} = (0.1)(35)$
$= 3.5V$

THIS PROBLEM IS EASIER TO SOLVE IF WE REDRAW.

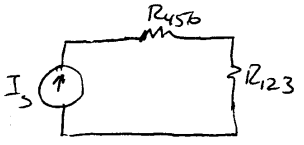


Fig 1

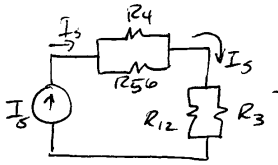


Fig 2

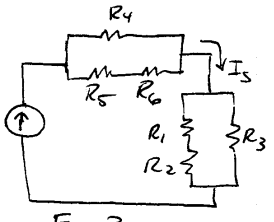


Fig. 3

FROM Fig. 1

$I_s = i_{R456} = i_{R123}$

$$V_{R456} = \frac{R_{456}}{R_{456} + R_{123}} \cdot V_{IS}$$

$$= \frac{20}{20 + 15} \cdot 3.5$$

$V_{R456} = 2V$

$$V_{R123} = \frac{R_{123}}{R_{456} + R_{123}} \cdot V_{IS}$$

$$= \frac{15}{20 + 15} \cdot 3.5$$

$V_{R123} = 1.5V$

EE301/303 S09 HW3 SOLUTION

PROBLEM 4 CONT.

FROM Fig 2: $V_{R4} = V_{R56} = V_{R456} = 2V$

$V_{R12} = V_{R3} = V_{R123} = 1.5V$

$$i_{R56} = \frac{\frac{1}{R_{56}}}{\frac{1}{R_4}+\frac{1}{R_{56}}} \cdot I_S = \frac{\frac{1}{40}}{\frac{1}{40}+\frac{1}{40}} = 100mA = 50mA = i_{R56}$$

$$i_{R3} = \frac{\frac{1}{R_3}}{\frac{1}{R_3}+\frac{1}{R_{12}}} \cdot I_S = \frac{\frac{1}{30}}{\frac{1}{30}+\frac{1}{30}} \cdot 100 = \underline{50mA = i_{R3}} \leftarrow$$

FROM Fig 3:

$i_{R5} = i_{R6} = i_{R56}$

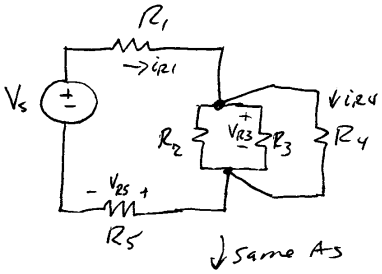
$\underline{i_{R6} = 50mA} \leftarrow$

$$V_{R6} = \frac{R_6}{R_5+R_6} \cdot V_{R56} = \frac{20}{20+20} \cdot 2 \rightarrow \underline{V_{R6} = 1V}$$

$$V_{R1} = \frac{R_1}{R_1+R_2} \cdot V_{R12} = \frac{15}{15+15} \cdot 1.5 \Rightarrow \underline{V_{R1} = 0.75V} \leftarrow$$

EE301/303 SP07 HW2 Solution

PROBLEM 5



↓ same as

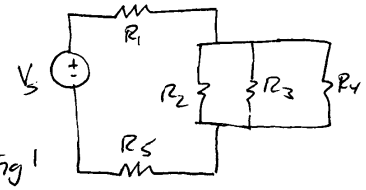


Fig 1

GIVEN: $R_1 = 15\Omega$, $R_2 = 10\Omega$, $R_3 = 5\Omega$, $R_4 = 10\Omega$, $R_5 = 2.5\Omega$, $V_s = 5V$

FIND: • $i_{R1}, i_{R4}, V_{R3}, V_{R5}$
• R_{eq}

$$R_{234} = R_2 /\!/ R_3 /\!/ R_4 = \frac{1}{\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}} = \frac{1}{\frac{1}{10}+\frac{1}{5}+\frac{1}{10}} = 2.5\Omega$$

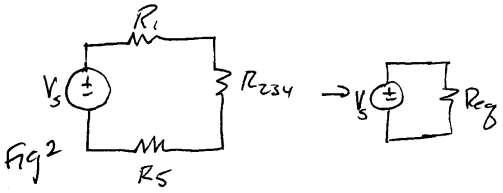


Fig 2

$$R_{1\to5} = R_1 + R_{234} + R_5 = 15 + 2.5 + 2.5 = 20\Omega$$

$$R_{eq} = 20\Omega \leftarrow$$

$$i_{VS} = \frac{V_s}{R_{eq}} = \frac{5}{20}$$

$$i_{VS} = 0.25A$$

From Fig. 2

$$i_{R1} = i_{R234} = i_{R5} = i_{VS}$$

$$i_{R1} = 0.25A \leftarrow$$

$$V_{R234} = \frac{R_{234}}{R_1 + R_{234} + R_5} \cdot V_s = \frac{2.5}{15 + 2.5 + 2.5} \cdot 5$$

$$V_{R234} = 0.625V$$

$$V_{R5} = \frac{R_5}{R_1 + R_{234} + R_5} \cdot V_s = \frac{2.5}{15 + 2.5 + 2.5} \cdot 5 = 0.625$$

$$V_{R5} = 0.625V \leftarrow$$

From Fig. 1

$$V_{R3} = V_{R234} = 0.625V$$

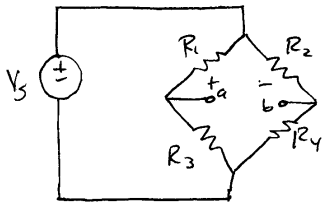
$$V_{R3} = 0.625V \leftarrow$$

$$i_{R4} = \frac{\frac{1}{R_4}}{\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}} \cdot i_{VS} = \frac{\frac{1}{10}}{\frac{1}{10}+\frac{1}{5}+\frac{1}{10}} \cdot 0.25$$

$$i_{R4} = 0.0625A \leftarrow$$

EE 301/303 SP09 HW 2 SOLUTION

PROBLEM 6



GIVEN: $V_s = 6V$, $R_1 = 5\Omega$, $R_2 = 10\Omega$
$R_3 = 10\Omega$, $R_4 = 5\Omega$

FIND: THE VOLTAGE BETWEEN NODES a & b V_{ab}

$$V_a = V_{R3} = \frac{R_3}{R_1 + R_3} \cdot V_s$$

$$= \frac{10}{5+10} \cdot 6 = 4V$$

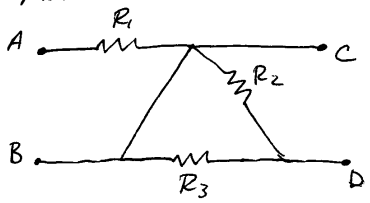
$$V_b = V_{R4} = \frac{R_4}{R_2 + R_4} \cdot V_s$$

$$= \frac{5}{5+10} \cdot 6 = 2V$$

$$V_{ab} = V_a - V_b = 4 - 2 = \underline{\underline{2V = V_{a5}}} \leftarrow$$

EE 301/303 Sp09 HW 2 Solution

PROBLEM 7

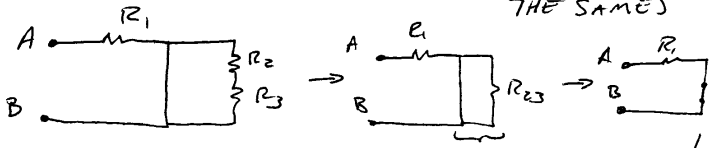


GIVEN: $R_1 = 60\Omega$ $R_2 = 100\Omega$
$R_3 = 100\Omega$

FIND: $R_{AB}, R_{BC}, R_{AC}, R_{CD}$
R_{BD}, R_{AD}

R_{AB}

(NOTICE NODES C & B ARE THE SAME)



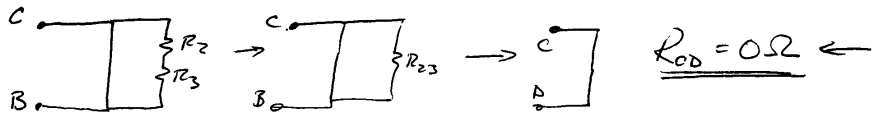
$R_{23} = R_2 + R_3 = 100 + 100 = 200\Omega$

$\hookrightarrow R_{23} // 0\Omega = \frac{1}{\frac{1}{R_{23}} + \frac{1}{0}} = 0\Omega$

RESISTOR IS DIRECTLY SHORTED

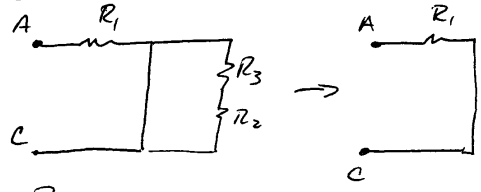
$R_{AB} = R_1 = 60\Omega = R_{AB}$ ←

R_{BC}



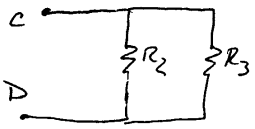
$R_{CD} = 0\Omega$ ←

R_{AC}



$R_{AC} = R_1 = 60\Omega = R_{AC}$ ←

R_{CD}

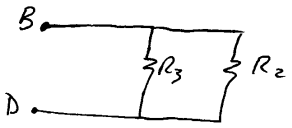


$R_{CD} = R_2 // R_3 = \frac{1}{\frac{1}{100} + \frac{1}{100}} = 50\Omega = R_{CD}$ ←

EE301/303 Sp09 HW 2 Solution

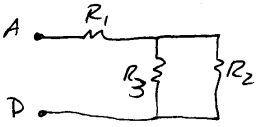
Problem 7 cont.

R_{BD}

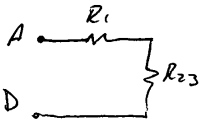


$R_{BD} = R_2 // R_3 = \frac{1}{\frac{1}{100}+\frac{1}{100}} = 50\,\Omega = R_{BD}$

R_{AD}



$R_{23} = R_2 // R_3 = \frac{1}{\frac{1}{100}+\frac{1}{100}} = 50\,\Omega$

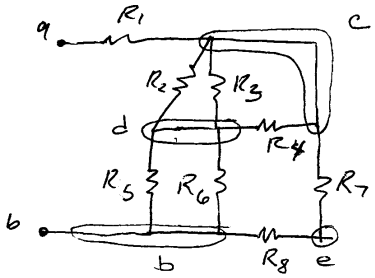


$R_{AD} = R_1 + R_{23} = 60 + 50$

$R_{AD} = 110\,\Omega$ ⟸

EE301/303 SP08 HW #2 SOLUTION

PROBLEM 2.47



GIVEN $R_1 = 3\Omega$, $R_2 = 6\Omega$, $R_3 = 12\Omega$
$R_4 = 4\Omega$, $R_5 = 4\Omega$ $R_6 = 4\Omega$
$R_7 = 2\Omega$, $R_8 = 2\Omega$

FIND: R_{ab}

R_2, R_3 & R_4 SHARE THE SAME 2 TERMINALS SO THEY ARE IN PARALLEL

$$R_{234} = \frac{1}{\frac{1}{R_2}+\frac{1}{R_3}+\frac{1}{R_4}} = \frac{1}{\frac{1}{6}+\frac{1}{12}+\frac{1}{4}}$$

$R_{234} = 2\Omega$ ← (Between c & d)

R_5 & R_6 ARE IN PARALLEL

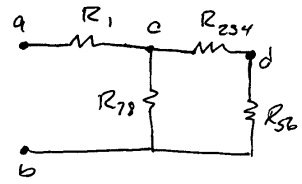
$$R_{56} = \frac{1}{\frac{1}{R_5}+\frac{1}{R_6}} = \frac{1}{\frac{1}{4}+\frac{1}{4}} = 2\Omega \leftarrow$$

(between c & b)

R_7 & R_8 ARE IN SERIES

$R_{78} = R_7 + R_8 = 2 + 2$

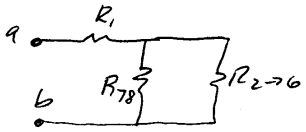
$R_{78} = 4\Omega$ ←
(between c & b)



$R_{23456} = R_{234} + R_{56}$

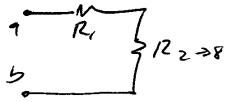
$= 2 + 2$

$R_{2\to6} = 4\Omega$



$R_{2\to8} = R_{78} // R_{2\to6} = \frac{1}{\frac{1}{4}+\frac{1}{4}} =$

$R_{2\to8} = 2\ \Omega$



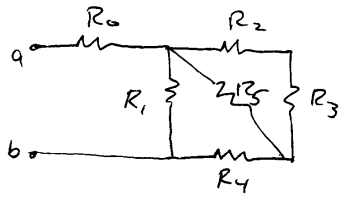
$R_{ab} = R_1 + R_{2\to8}$

$= 3 + 2$

$R_{ab} = 5\ \Omega$ ←

EE301/303 SP08 HW#2 SOLUTION

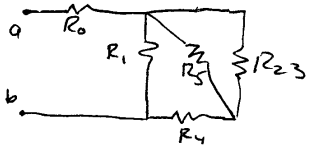
PROBLEM 2.59



GIVEN: $R_0 = 4\Omega$, $R_1 = 12\Omega$, $R_2 = 8\Omega$
$R_3 = 2\Omega$, $R_4 = 16\Omega$, $R_5 = 5\Omega$

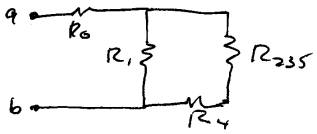
FIND: R_{ab}

$R_{23} = R_2 + R_3 = 8 + 2 = 10\Omega = R_{23}$



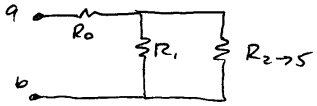
$$R_{235} = R_{23} /\!/ R_5 = \frac{1}{\frac{1}{R_{23}} + \frac{1}{R_5}}$$

$$= \frac{1}{\frac{1}{10} + \frac{1}{5}} = 3\tfrac{1}{3}\Omega$$



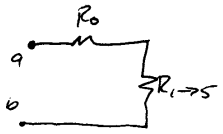
$R_{2345} = R_4 + R_{235} = 16 + 3\tfrac{1}{3}$

$R_{2\to5} = 19\tfrac{1}{3}\Omega$



$$R_{1\to5} = R_1 /\!/ R_{2\to5} = \frac{1}{\frac{1}{12} + \frac{1}{19\frac{1}{3}}}$$

$R_{1\to5} = 7.4\Omega$

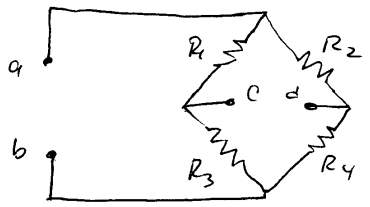


$R_{ab} = R_0 + R_{1\to5}$
$= 4 + 7.4$

$R_{ab} = 11.4\Omega$ ←

EE301/303 Spo8 HW #2 Solution

PROBLEM 2.64

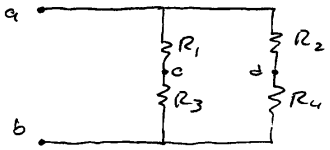


GIVEN: $R_1 = 360\Omega$, $R_2 = 180\Omega$
$R_3 = 540\Omega$, $R_4 = 540\Omega$

FIND: R_{ab} IF 1) cd OPEN
2) cd SHORTED

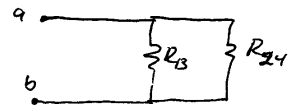
• R_{cd} IF 1.) ab OPEN
2.) cd SHORTED

R_{ab} w/ CD OPEN



$R_{13} = R_1 + R_3 = 360 + 540 = 900\Omega = R_{13}$

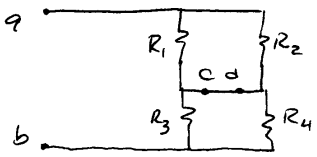
$R_{24} = R_2 + R_4 = 180 + 540 = 720\Omega = R_{24}$

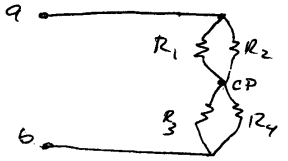


$$R_{ab} = R_{13} \parallel R_{24} = \frac{1}{\frac{1}{R_{13}} + \frac{1}{R_{24}}} = \frac{1}{\frac{1}{900} + \frac{1}{720}}$$

$R_{ab} = 400\Omega$ ←

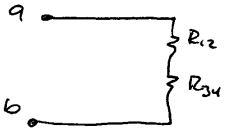
R_{ab} w/ CD SHORTED





$$R_{12} = R_1 \parallel R_2 = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{1}{\frac{1}{360} + \frac{1}{180}} = 120\Omega = R_{12}$$

$$R_{34} = R_3 \parallel R_4 = \frac{1}{\frac{1}{R_3} + \frac{1}{R_4}} = \frac{1}{\frac{1}{540} + \frac{1}{540}} = 270\Omega = R_{34}$$



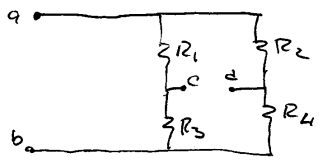
$R_{ab} = R_{12} + R_{34} = 120 + 270 = 390\Omega$

$R_{ab} = 390\Omega$ ←

EE301/303 SP08 HW #2 SOLUTION

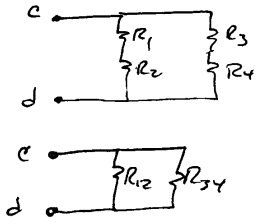
PROBLEM 2.64 CONT.

R_{cd} w/ab OPEN



$R_{12} = R_1 + R_2 = 360 + 180 = 540\,\Omega = R_{12}$

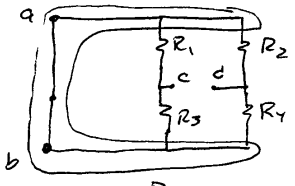
$R_{34} = R_3 + R_4 = 540 + 540 = 1080\,\Omega = R_{34}$

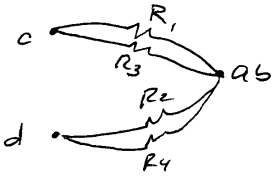


$R_{cd} = R_{12} \| R_{34} = \frac{1}{\frac{1}{R_{12}} + \frac{1}{R_{34}}} = \frac{1}{\frac{1}{540} + \frac{1}{1080}} = 360$

$R_{cd} = 360\,\Omega \leftarrow$

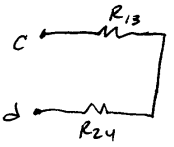
R_{cd} w/ab shorted





$R_{13} = R_1 \| R_3 = \frac{1}{\frac{1}{R_1} + \frac{1}{R_3}} = \frac{1}{\frac{1}{360} + \frac{1}{540}} = 216\,\Omega = R_{13}$

$R_{24} = R_2 \| R_4 = \frac{1}{\frac{1}{R_2} + \frac{1}{R_4}} = \frac{1}{\frac{1}{180} + \frac{1}{540}} = 135\,\Omega = R_{24}$

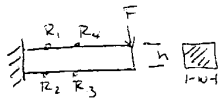


$R_{cd} = R_{13} + R_{24} = 216 + 135$

$R_{cd} = 351\,\Omega \leftarrow$

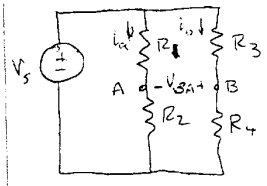
EE 30 Fall 07 HW # 2 Solutions

PROBLEM 2.79



Given $V_{BA} = 50mV$

Find F when $R_0 = 1k\Omega$
$w = 25mm$
$V_s = 12V$
$h = 100mm$
$L = 0.3\ m$
$Y = 69\ GN/m^2$



$R_1 = R_4 = R_0 + \Delta R$

$R_2 = R_3 = R_0 - \Delta R$

From $\epsilon = \frac{6LF}{wh^2Y}$

$i_a = \frac{V_s}{R_1+R_2}$ $\quad i_b = \frac{V_s}{R_3+R_4}$

$V_a = \frac{R_2}{R_1+R_2} \cdot V_s$ $\quad V_b = \frac{R_4}{R_3+R_4} \cdot V_s$

$V_{BA} = V_b - V_a = \frac{R_4}{R_3+R_4} \cdot V_s - \frac{R_2}{R_1+R_2} \cdot V_s$

$V_{BA} = V_s\left(\frac{R_4}{R_3+R_4} - \frac{R_2}{R_1+R_2}\right)$

$V_s\left(\frac{R_0+\Delta R}{R_0-\Delta R+R_0+\Delta R} - \frac{R_0-\Delta R}{(R_0+\Delta R+R_0-\Delta R)}\right)$

$V_{BA} = V_s \cdot \frac{2\Delta R}{2R_0} = \frac{\Delta R}{R_0} V_s$

$\Delta R = R_0 \epsilon F_G$ $\quad F_G$ is gage factor $F_G = 2$

$\Delta R = \frac{R_0 6LF F_G}{wh^2Y} \Rightarrow V_{BA} = \frac{R_0 6LF F_G}{wh^2 Y R_0} \cdot V_s$

$F = \frac{V_{BA} wh^2 Y}{6LF_G V_s} = \frac{(50\times10^{-3})(25\times10^{-3})(100\times10^{-3})^2(69\times10^9)}{6(0.3)(12)(2)}$

$F = 19.96kN \leftarrow$