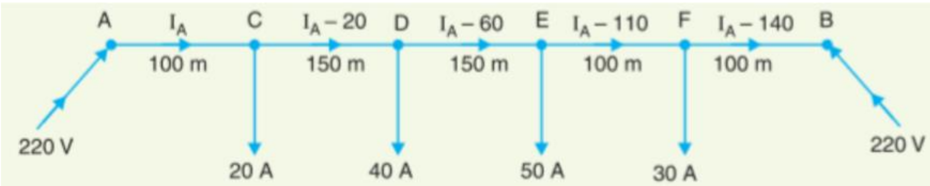
LTspice simulations for DC distribution systems

LTspice simulator, you can download it for free: https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html

Task: Find currents in the arms AC, CD, DE, EF, and FB in the DC distribution system with two voltage sources at both ends. The main equation is $V_B = V_A - V_{AB}$, where V_{AB} is the total voltage drop along AB for the chosen current directions. We initially assume that all currents flow in a specific positive direction along the line. However, in the calculation process, it's possible that some currents might appear negative, indicating their actual direction is opposite to the originally chosen direction.



Resistance of 1 m length of distributor

$$= 2 \times \frac{1{\cdot}7 \times 10^{-6} \times 100}{1} = 3{\cdot}4 \times 10^{-4}\ \Omega$$

$$\text{Resistance of section } AC, R_{AC} = (3{\cdot}4 \times 10^{-4}) \times 100 = 0{\cdot}034\ \Omega$$

$$\text{Resistance of section } CD, R_{CD} = (3{\cdot}4 \times 10^{-4}) \times 150 = 0{\cdot}051\ \Omega$$

$$\text{Resistance of section } DE, R_{DE} = (3{\cdot}4 \times 10^{-4}) \times 150 = 0{\cdot}051\ \Omega$$

$$\text{Resistance of section } EF, R_{EF} = (3{\cdot}4 \times 10^{-4}) \times 100 = 0{\cdot}034\ \Omega$$

$$\text{Resistance of section } FB, R_{FB} = (3{\cdot}4 \times 10^{-4}) \times 100 = 0{\cdot}034\ \Omega$$

The loads' utility is defined based on consumption currents rather than resistances. Resistances serve to characterize losses in the distribution system between nodes from which the load currents are drawn. Analytical solution:

$$\text{Voltage at } B = \text{Voltage at } A - \text{Drop over length } AB$$

or

$$V_B = V_A - [I_A R_{AC} + (I_A - 20) R_{CD} + (I_A - 60) R_{DE} + (I_A - 110) R_{EF} + (I_A - 140) R_{FB}]$$

or

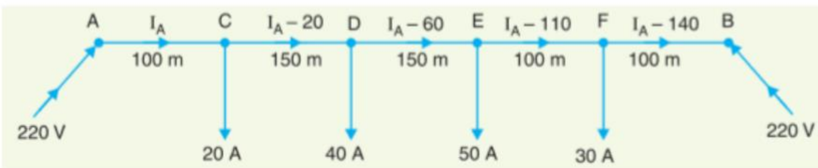
$$220 = 220 - [0{\cdot}034\, I_A + 0{\cdot}051\,(I_A - 20) + 0{\cdot}051\,(I_A - 60) + 0{\cdot}034\,(I_A - 110) + 0{\cdot}034\,(I_A - 140)]$$

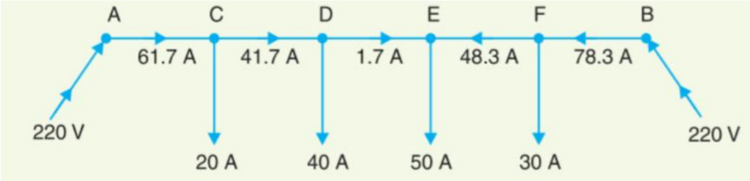
$$= 220 - [0{\cdot}204\, I_A - 12{\cdot}58]$$

or

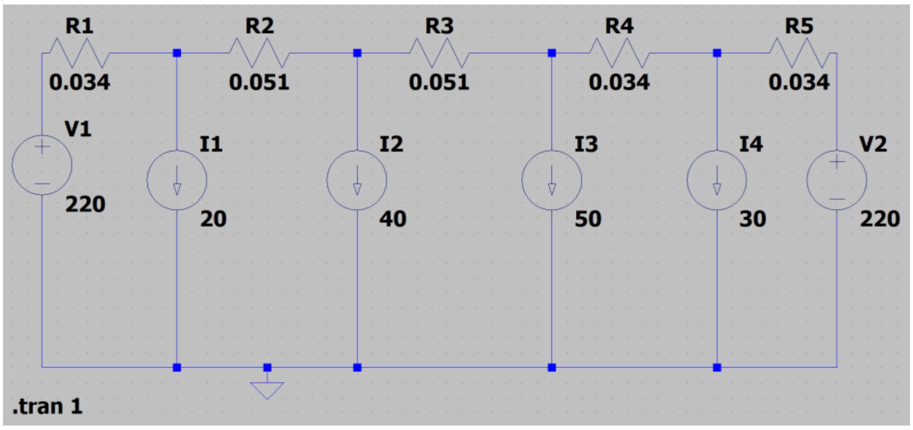
$$0{\cdot}204\, I_A = 12{\cdot}58$$

$$\therefore\ I_A = 12{\cdot}58/0{\cdot}204 = 61{\cdot}7 \text{ A}$$

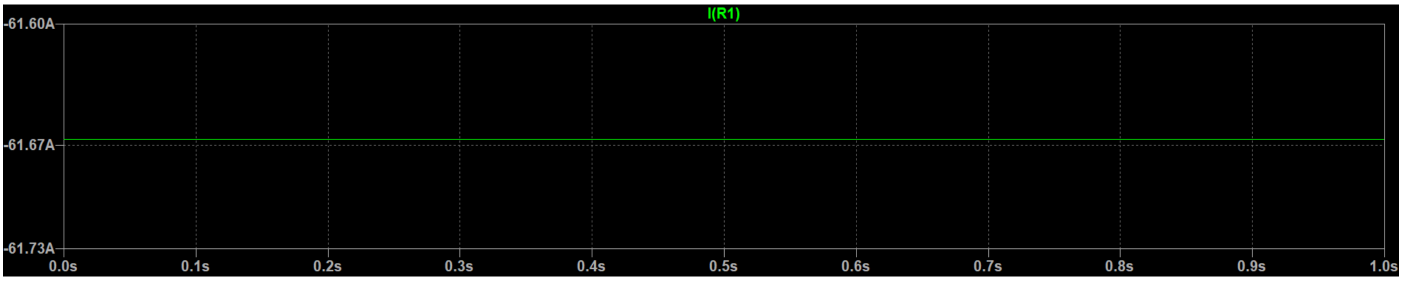


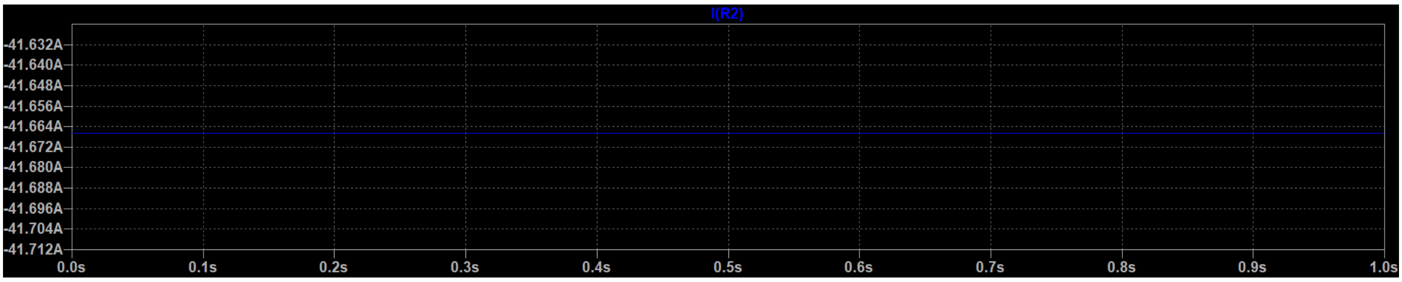


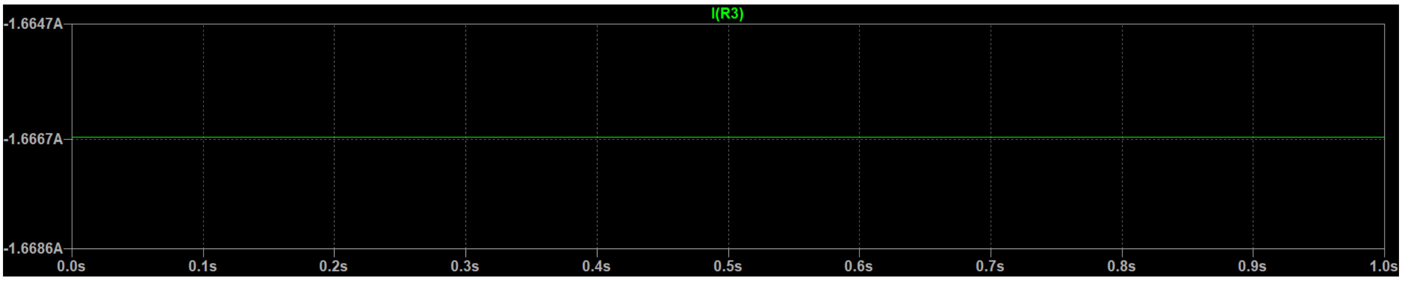
In LTspice, constant current sources are utilized instead of resistors to represent the consumption characteristics (file "DC_Both_Ends_1.asc" in the folder "LTspice_DC_distribution_systems"):

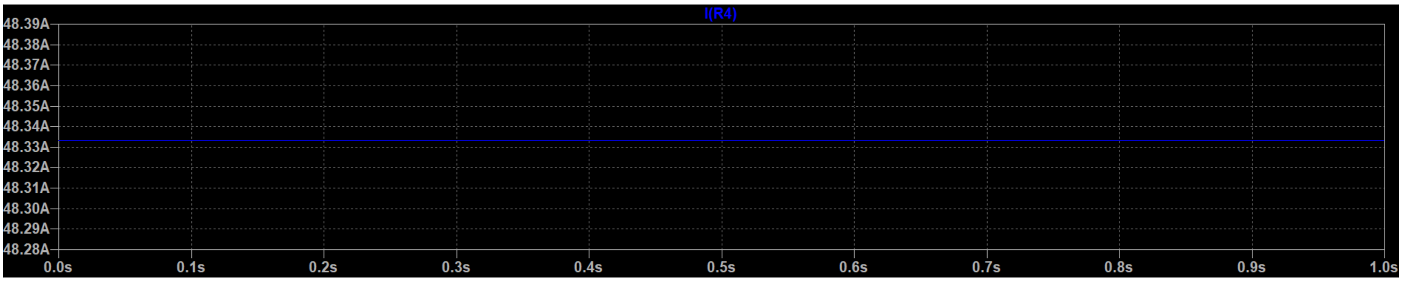


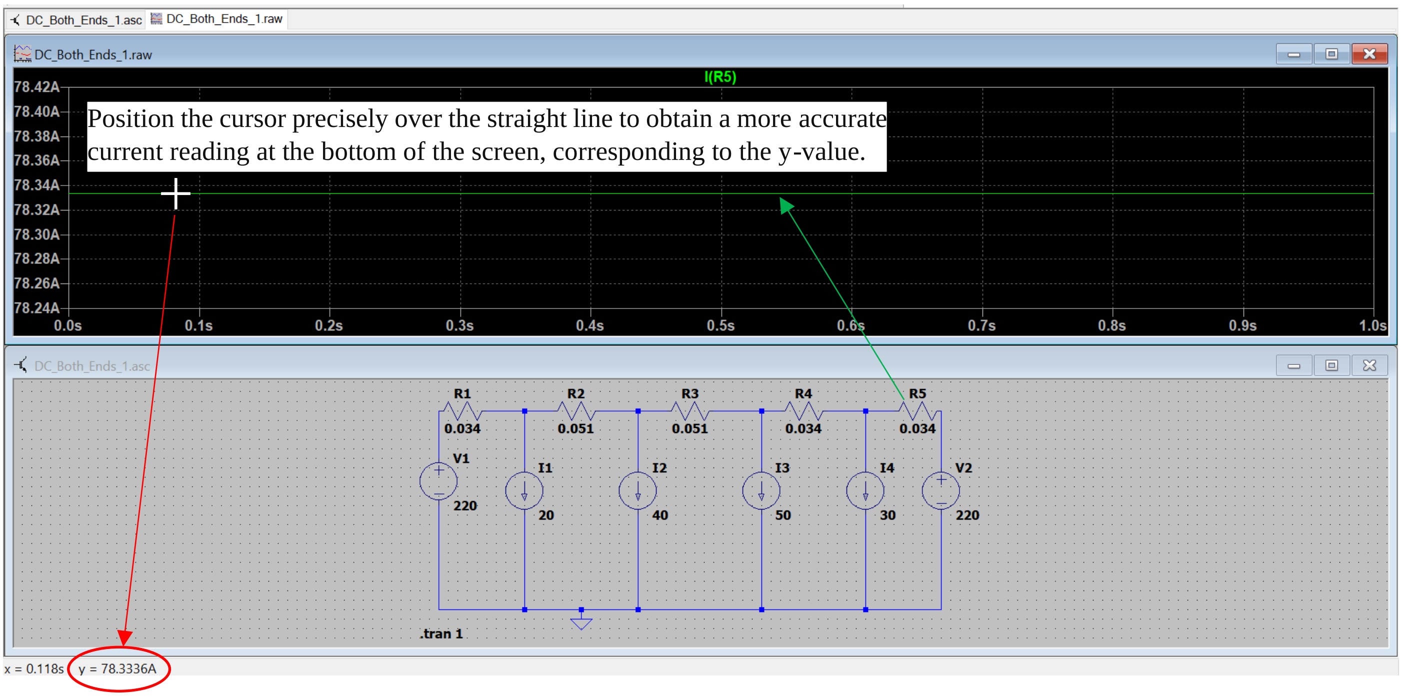
Double left-click on R1, R2, R3, R4, or R5 to show the current simulation (straight line). A single left-click will retain the previous reading of the current. Simulation time doesn't factor in since we're dealing with constant voltages and currents. We've set it to 1 second (**.tran 1**). For some reason, LTspice displays currents with opposite signs. Please consider this when verifying your analytical solutions:





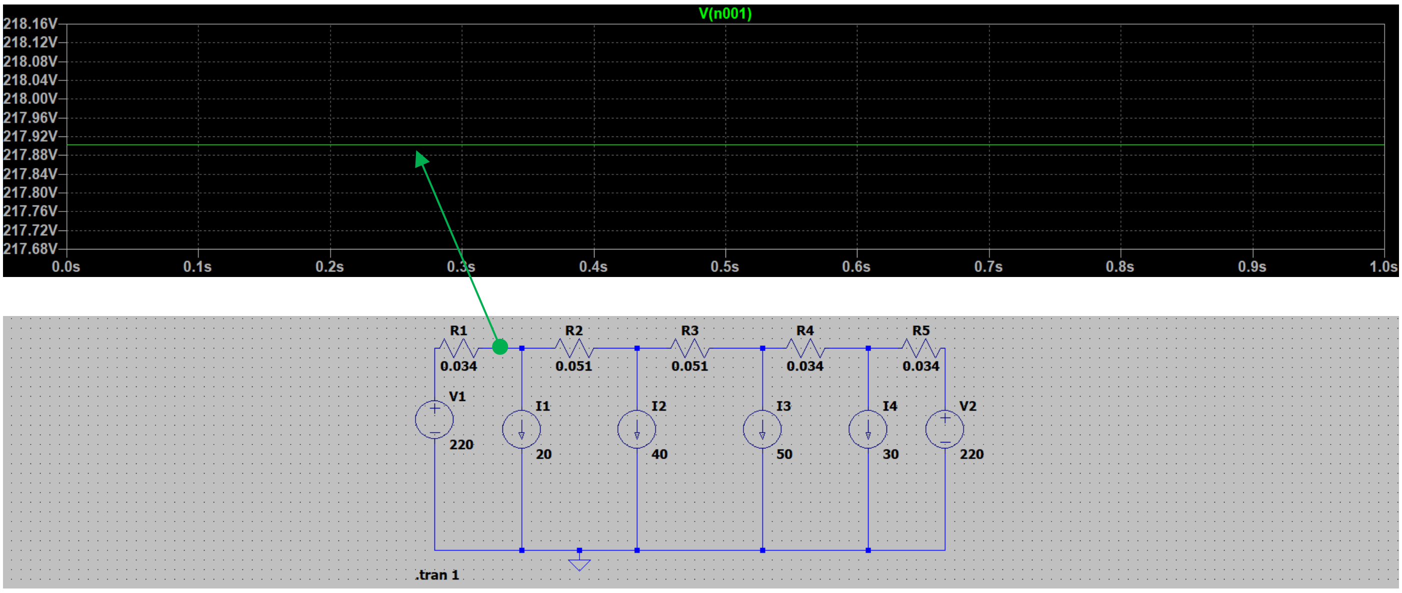


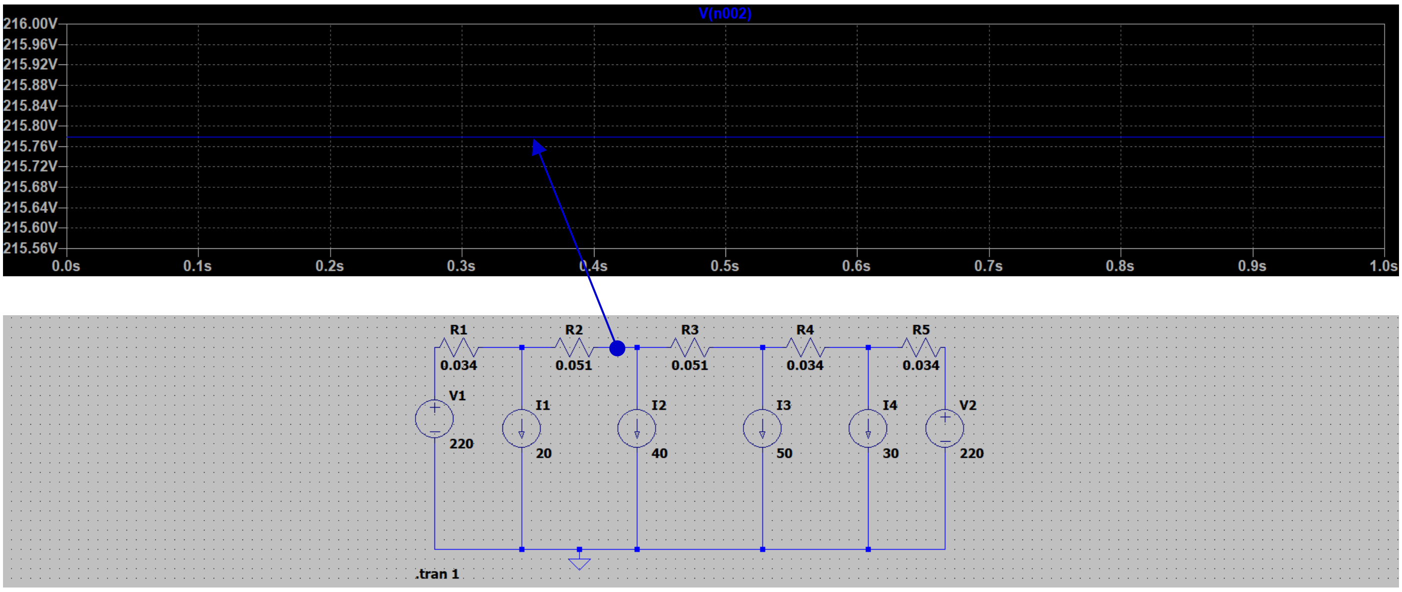


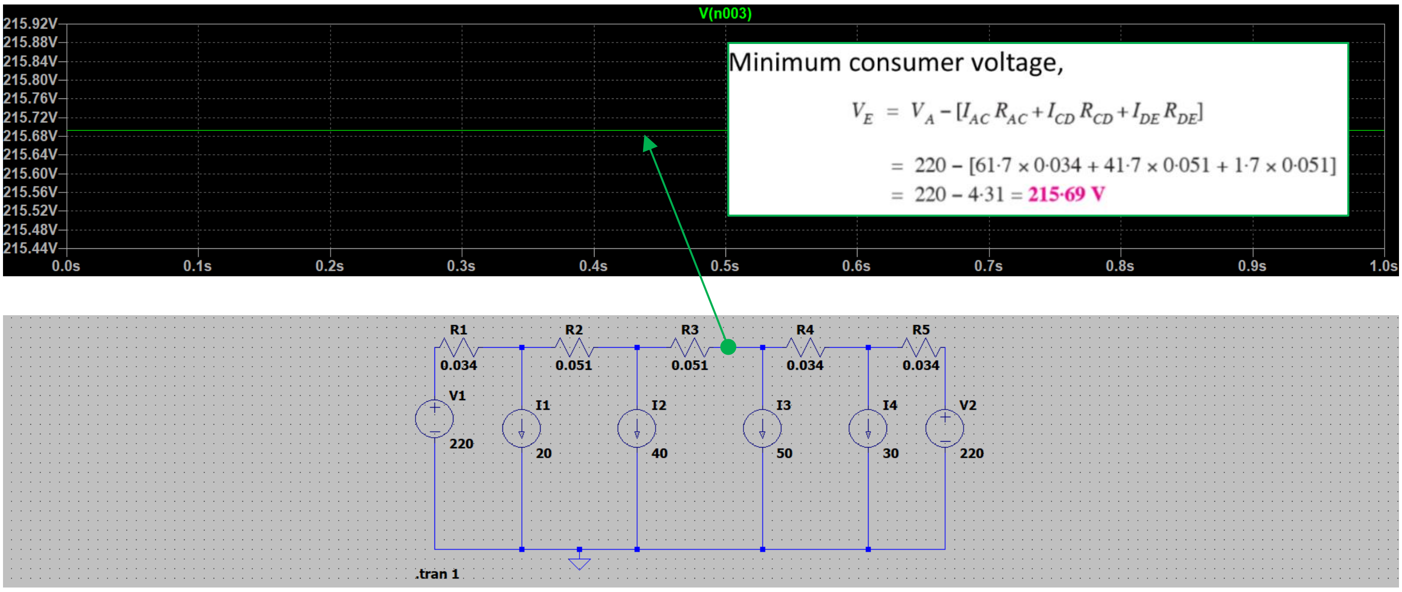


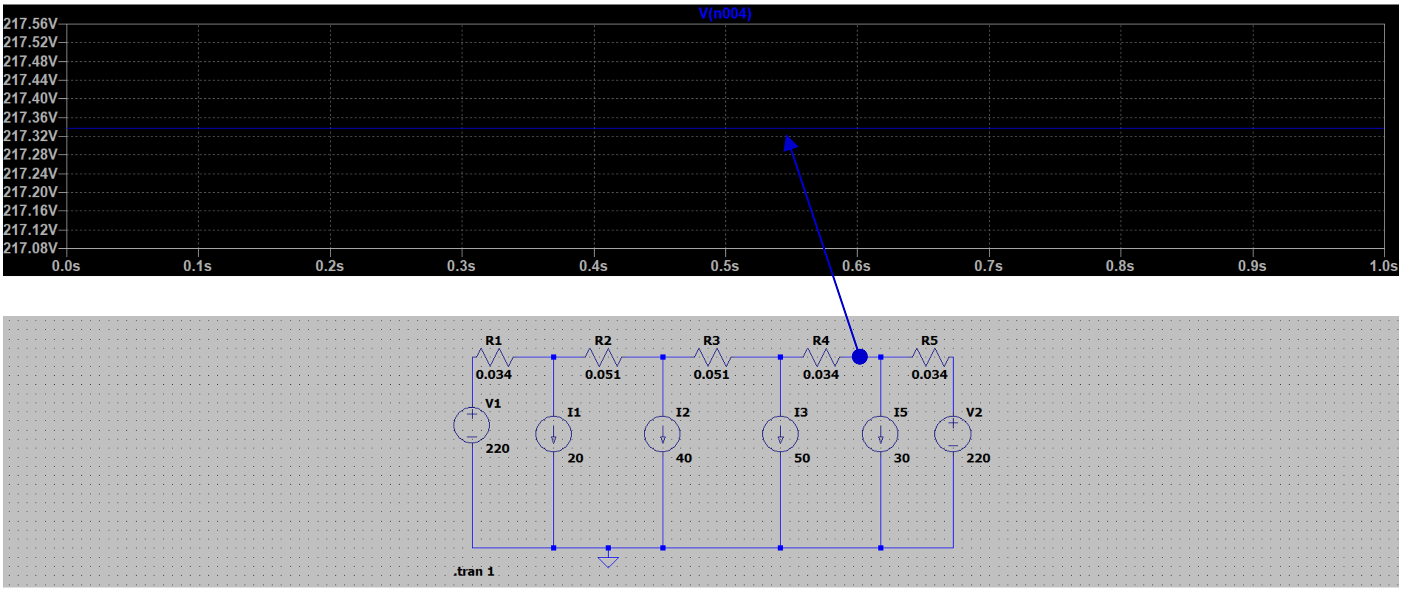
In LTspice, the current direction displayed might seem opposite to what one might expect based on the conventional assumption. This occurrence can sometimes puzzle users who are new to the software or those who haven't encountered this behaviour before. It's more about how LTspice represents current flow rather than adhering strictly to the conventional assumption. If you've just discovered this feature and find it unexpected or puzzling, that's completely normal. Learning about these software-specific behaviours often takes time and experimentation.

To measure the voltage at a specific test point, left-click the cursor on the wire passing through that point:






V(n003)
215.92V
215.88V
215.84V
215.80V
215.76V
215.72V
215.68V
215.64V
215.60V
215.56V
215.52V
215.48V
215.44V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
Minimum consumer voltage,
$V_E = V_A - [I_{AC} R_{AC} + I_{CD} R_{CD} + I_{DE} R_{DE}]$
$= 220 - [61{\cdot}7 \times 0{\cdot}034 + 41{\cdot}7 \times 0{\cdot}051 + 1{\cdot}7 \times 0{\cdot}051]$
$= 220 - 4{\cdot}31 = 215{\cdot}69$ V
R1
0.034
R2
0.051
R3
0.051
R4
0.034
R5
0.034
V1
220
I1
20
I2
40
I3
50
I4
30
V2
220
.tran 1


V(n004)
217.56V
217.52V
217.48V
217.44V
217.40V
217.36V
217.32V
217.28V
217.24V
217.20V
217.16V
217.12V
217.08V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.034
R2
0.051
R3
0.051
R4
0.034
R5
0.034
V1
220
I1
20
I2
40
I3
50
I5
30
V2
220
.tran 1

Task:

A 2-wire d.c. distributor AB is fed from both ends. At feeding point A, the voltage is maintained at 230 V and at B 235 V. The total length of the distributor is 200 metres and loads are tapped off as follows:

25 A at 50 metres from A ; 50 A at 75 metres from A

30 A at 100 metres from A ; 40 A at 150 metres from A

The resistance per kilometre of one conductor is 0·3Ω. Calculate: (i) currents in various sections of the distributor (ii) minimum voltage and the point at which it occurs

Solution:

Resistance of 1000 m length of distributor (both wires)

$$= 2 \times 0{\cdot}3 = 0{\cdot}6\ \Omega$$

Resistance of section AC, $R_{AC} = 0{\cdot}6 \times 50/1000 = 0{\cdot}03\ \Omega$

Resistance of section CD, $R_{CD} = 0{\cdot}6 \times 25/1000 = 0{\cdot}015\ \Omega$

Resistance of section DE, $R_{DE} = 0{\cdot}6 \times 25/1000 = 0{\cdot}015\ \Omega$

Resistance of section EF, $R_{EF} = 0{\cdot}6 \times 50/1000 = 0{\cdot}03\ \Omega$

Resistance of section FB, $R_{FB} = 0{\cdot}6 \times 50/1000 = 0{\cdot}03\ \Omega$

Voltage at B = Voltage at A – Drop over AB

$$V_B = V_A - [I_A R_{AC} + (I_A - 25) R_{CD} + (I_A - 75) R_{DE} + (I_A - 105) R_{EF} + (I_A - 145) R_{FB}]$$

$$235 = 230 - [0{\cdot}03\, I_A + 0{\cdot}015\, (I_A - 25) + 0{\cdot}015\, (I_A - 75) + 0{\cdot}03\, (I_A - 105) + 0{\cdot}03\, (I_A - 145)]$$

$$235 = 230 - [0{\cdot}12\, I_A - 9]$$

$$\therefore \quad I_A = \frac{239 - 235}{0{\cdot}12} = 33{\cdot}34\ \text{A}$$

(i) ∴ Current in section AC, $I_{AC} = I_A = \mathbf{33{\cdot}34\ A}$

Current in section CD, $I_{CD} = I_A - 25 = 33{\cdot}34 - 25 = \mathbf{8{\cdot}34\ A}$

Current in section DE, $I_{DE} = I_A - 75 = 33{\cdot}34 - 75 = -41{\cdot}66$ A *from D to E*

$= \mathbf{41{\cdot}66\ A}$ *from E to D*

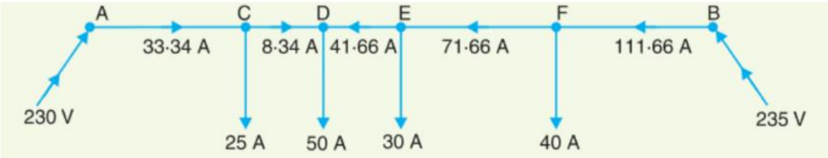
Current in section EF, $I_{EF} = I_A - 105 = 33{\cdot}34 - 105 = -71{\cdot}66$ A *from E to F*

$= \mathbf{71{\cdot}66\ A}$ *from F to E*

Current in section FB, $I_{FB} = I_A - 145 = 33{\cdot}34 - 145 = -111{\cdot}66$ A *from F to B*

$= \mathbf{111{\cdot}66\ A}$ *from B to F*

(ii) The actual distribution of currents in the various sections of the distributor

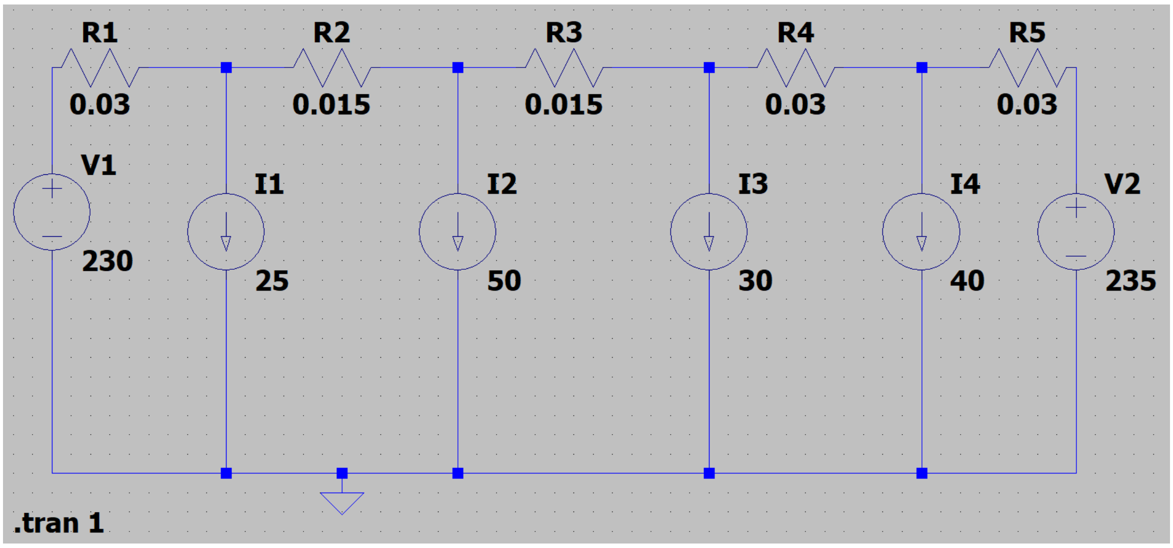


Voltage at D, $V_D = V_A - [I_{AC} R_{AC} + I_{CD} R_{CD}]$

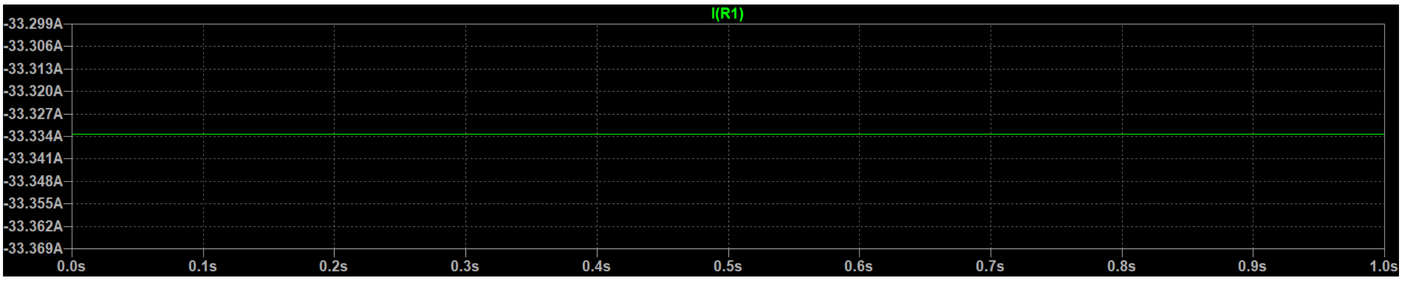
$= 230 - [33{\cdot}34 \times 0{\cdot}03 + 8{\cdot}34 \times 0{\cdot}015]$

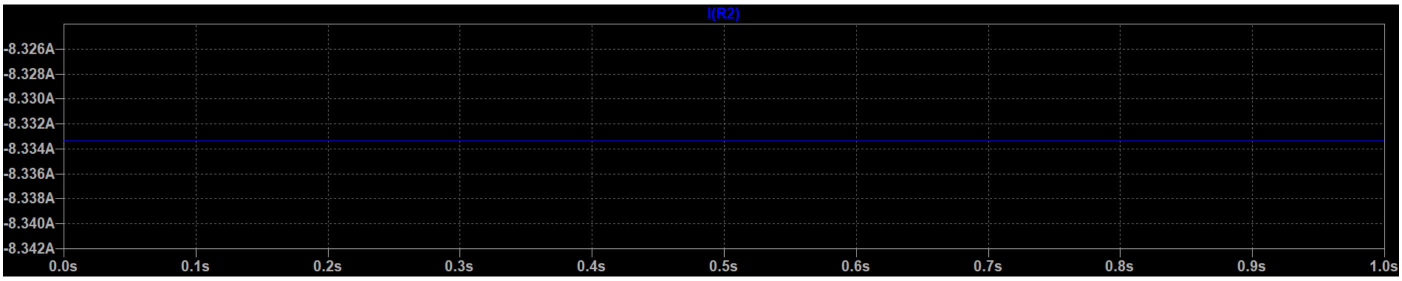
$= 230 - 1{\cdot}125 = \mathbf{228{\cdot}875\ V}$

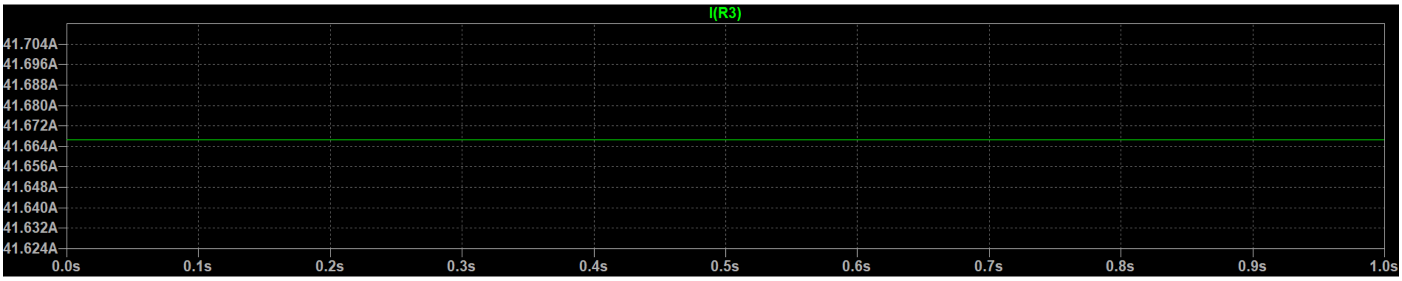
File “DC_Both_Ends_2.asc” in the folder “LTspice_DC_distribution_systems”:

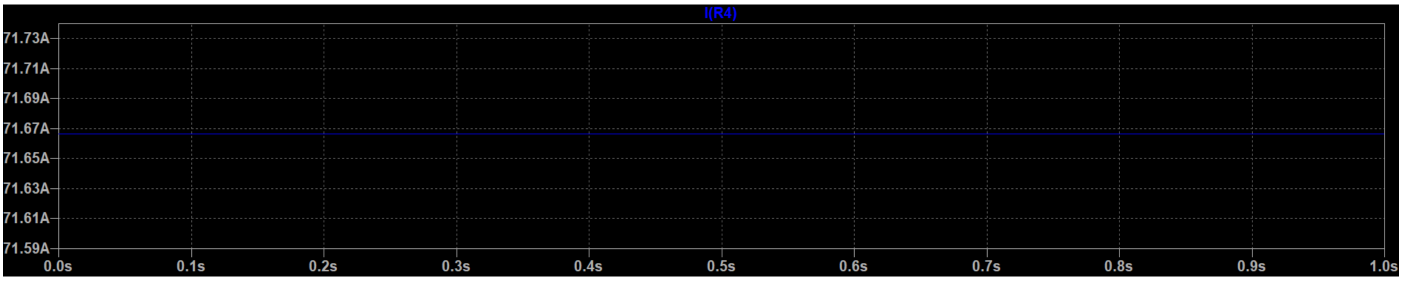


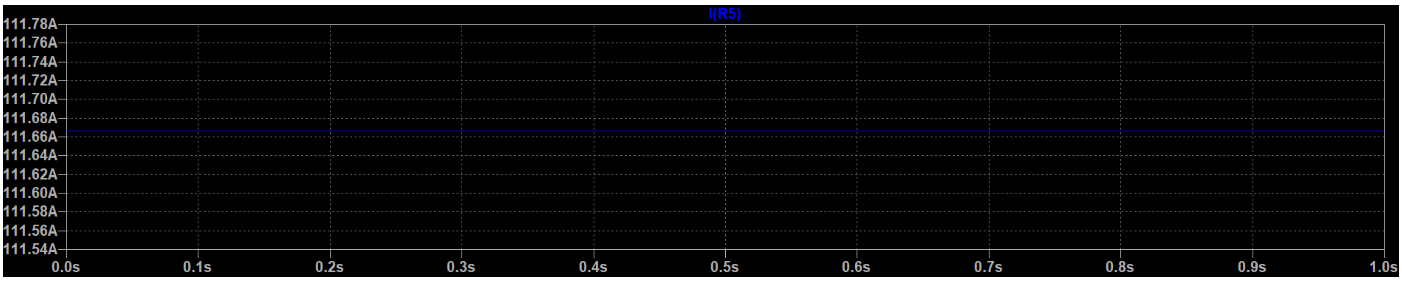
Simulation of the currents through R1-R5. Keep in mind the sign convention in LTspice when interpreting the results. The software might represent values with different signs than expected due to the usual convention:

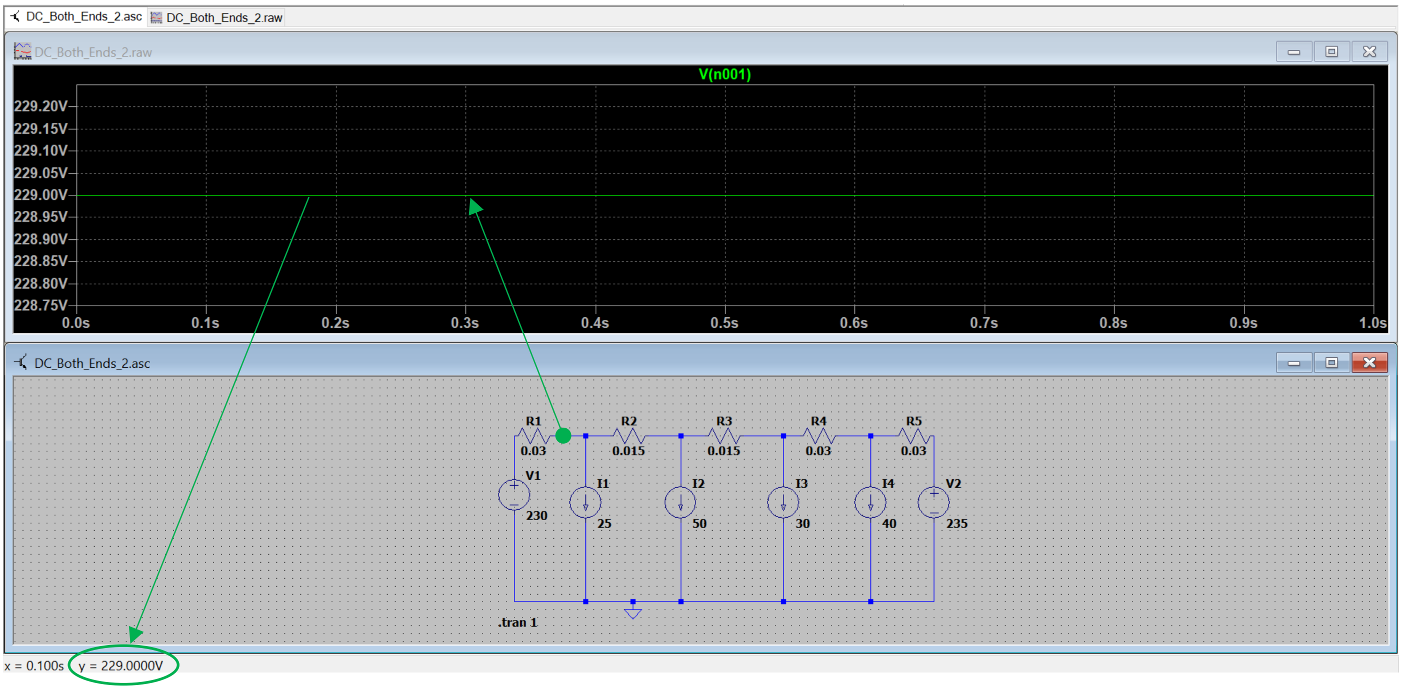


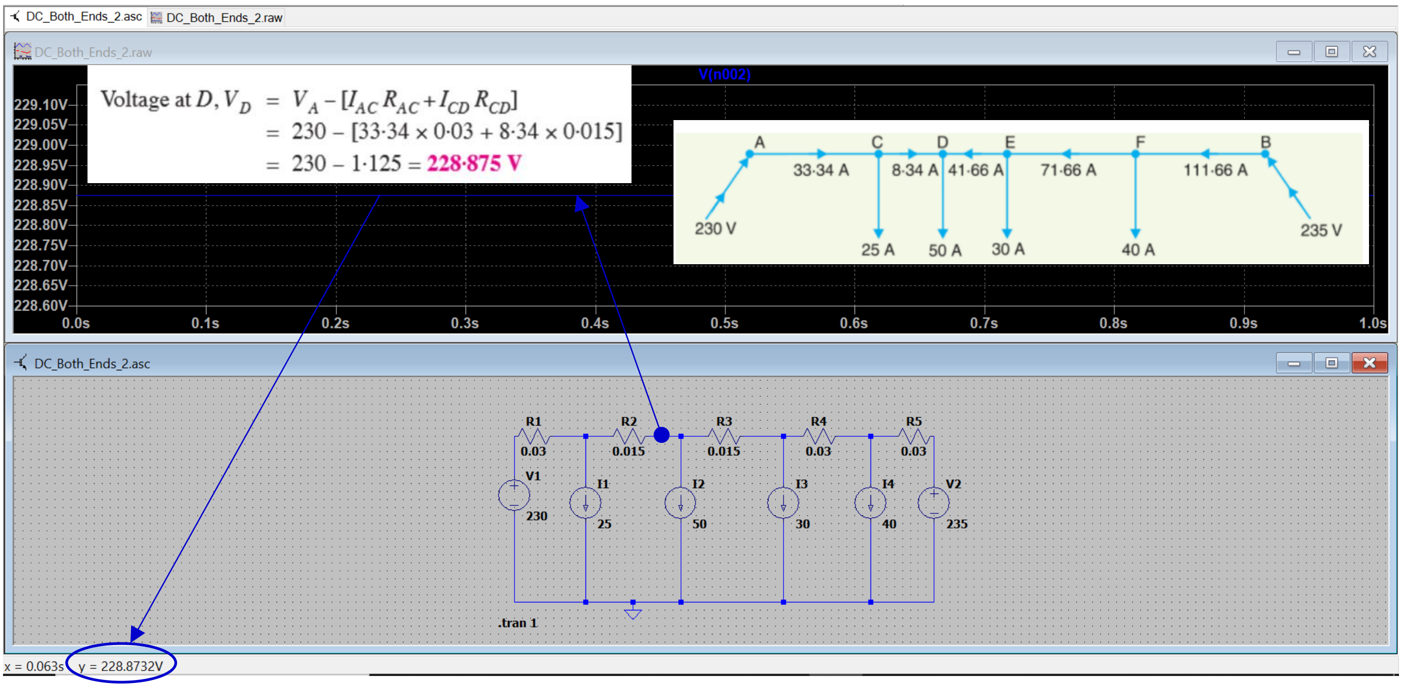

I(R2)
-8.326A
-8.328A
-8.330A
-8.332A
-8.334A
-8.336A
-8.338A
-8.340A
-8.342A
0.0s 0.1s 0.2s 0.3s 0.4s 0.5s 0.6s 0.7s 0.8s 0.9s 1.0s

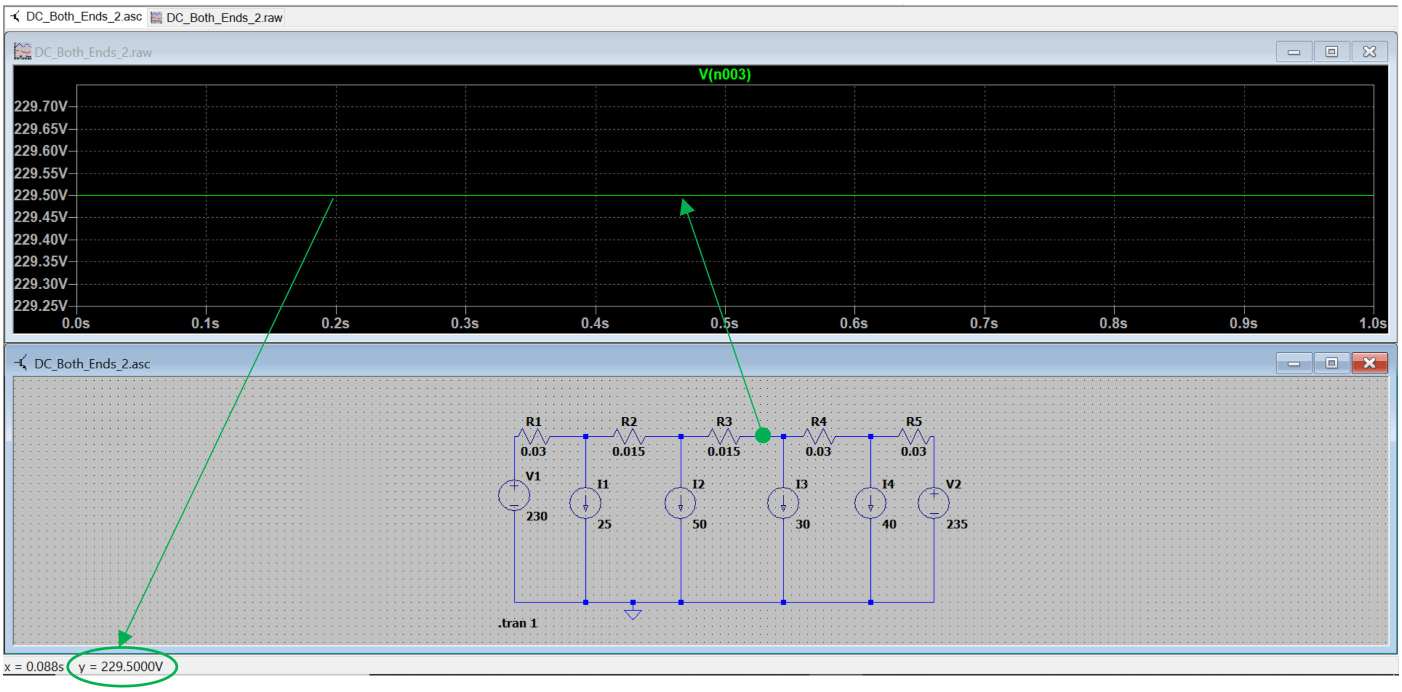

I(R3)
41.704A
41.696A
41.688A
41.680A
41.672A
41.664A
41.656A
41.648A
41.640A
41.632A
41.624A
0.0s 0.1s 0.2s 0.3s 0.4s 0.5s 0.6s 0.7s 0.8s 0.9s 1.0s

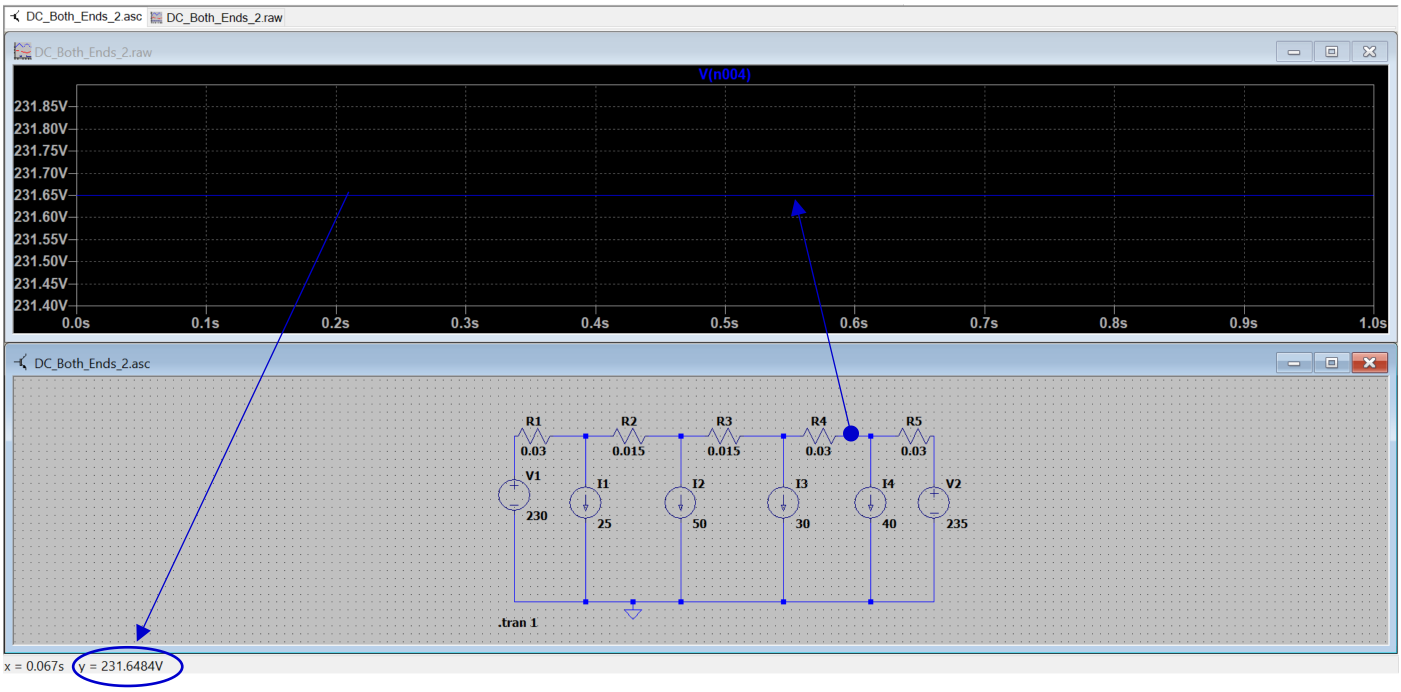

I(R4)
71.73A
71.71A
71.69A
71.67A
71.65A
71.63A
71.61A
71.59A
0.0s 0.1s 0.2s 0.3s 0.4s 0.5s 0.6s 0.7s 0.8s 0.9s 1.0s


I(R5)
111.78A
111.76A
111.74A
111.72A
111.70A
111.68A
111.66A
111.64A
111.62A
111.60A
111.58A
111.56A
111.54A
0.0s 0.1s 0.2s 0.3s 0.4s 0.5s 0.6s 0.7s 0.8s 0.9s 1.0s


DC_Both_Ends_2.asc
DC_Both_Ends_2.raw
V(n001)
229.20V
229.15V
229.10V
229.05V
229.00V
228.95V
228.90V
228.85V
228.80V
228.75V
0.0s 0.1s 0.2s 0.3s 0.4s 0.5s 0.6s 0.7s 0.8s 0.9s 1.0s
R1 0.03
R2 0.015
R3 0.015
R4 0.03
R5 0.03
V1 230
I1 25
I2 50
I3 30
I4 40
V2 235
.tran 1
x = 0.100s
y = 229.0000V

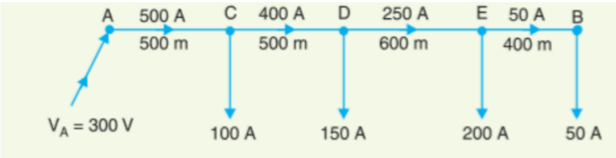

DC_Both_Ends_2.asc
DC_Both_Ends_2.raw
V(n002)
Voltage at D, $V_D = V_A - [I_{AC} R_{AC} + I_{CD} R_{CD}]$
$= 230 - [33{\cdot}34 \times 0{\cdot}03 + 8{\cdot}34 \times 0{\cdot}015]$
$= 230 - 1{\cdot}125 = 228{\cdot}875$ V
A
C
D
E
F
B
33·34 A
8·34 A
41·66 A
71·66 A
111·66 A
230 V
235 V
25 A
50 A
30 A
40 A
R1 0.03
R2 0.015
R3 0.015
R4 0.03
R5 0.03
V1 230
I1 25
I2 50
I3 30
I4 40
V2 235
.tran 1
x = 0.063s
y = 228.8732V


DC_Both_Ends_2.asc
DC_Both_Ends_2.raw
V(n003)
R1 0.03
R2 0.015
R3 0.015
R4 0.03
R5 0.03
V1 230
I1 25
I2 50
I3 30
I4 40
V2 235
.tran 1
x = 0.088s
y = 229.5000V


DC_Both_Ends_2.asc
DC_Both_Ends_2.raw
V(n004)
231.85V
231.80V
231.75V
231.70V
231.65V
231.60V
231.55V
231.50V
231.45V
231.40V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1 0.03
R2 0.015
R3 0.015
R4 0.03
R5 0.03
V1 230
I1 25
I2 50
I3 30
I4 40
V2 235
.tran 1
x = 0.067s
y = 231.6484V

Task:

A 2-wire d.c. distributor cable AB is 2 km long and supplies loads of 100A, 150A, 200A and 50A situated 500 m, 1000 m, 1600 m and 2000 m from the feeding point A. Each conductor has a resistance of 0·01 Ω per 1000 m. Calculate the p.d. at each load point if a p.d. of 300 V is maintained at point A.



Solution:

The fundamental condition for a distribution system fed at one end is that the incoming current equals the sum of all currents branching across the loads.

Resistance per 1000 m of distributor $= 2 \times 0{\cdot}01 = 0{\cdot}02\ \Omega$

Resistance of section $AC, R_{AC} = 0{\cdot}02 \times 500/1000 = 0{\cdot}01\ \Omega$

Resistance of section $CD, R_{CD} = 0{\cdot}02 \times 500/1000 = 0{\cdot}01\ \Omega$

Resistance of section $DE, R_{DE} = 0{\cdot}02 \times 600/1000 = 0{\cdot}012\ \Omega$

Resistance of section $EB, R_{EB} = 0{\cdot}02 \times 400/1000 = 0{\cdot}008\ \Omega$

Referring to Fig. 13.6, the currents in the various sections of the distributor are :

$I_{EB} = 50$ A ; $\quad I_{DE} = 50 + 200 = 250$ A

$I_{CD} = 250 + 150 = 400$ A ; $\quad I_{AC} = 400 + 100 = 500$ A

P.D. at load point C, V_C = Voltage at A – Voltage drop in AC

$= V_A - I_{AC} R_{AC}$

$= 300 - 500 \times 0{\cdot}01 =$ **295 V**

P.D. at load point D, $V_D = V_C - I_{CD} R_{CD}$

$= 295 - 400 \times 0{\cdot}01 =$ **291 V**

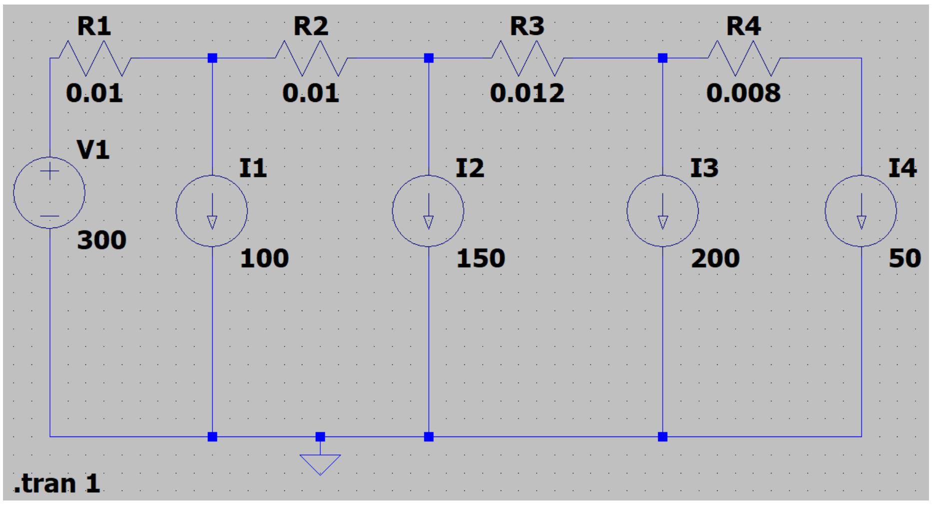
P.D. at load point E, $V_E = V_D - I_{DE} R_{DE}$

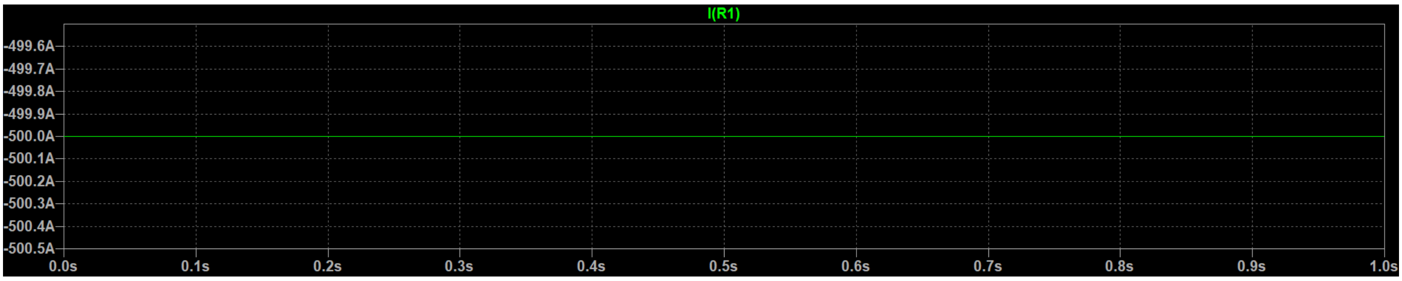
$= 291 - 250 \times 0{\cdot}012 =$ **288 V**

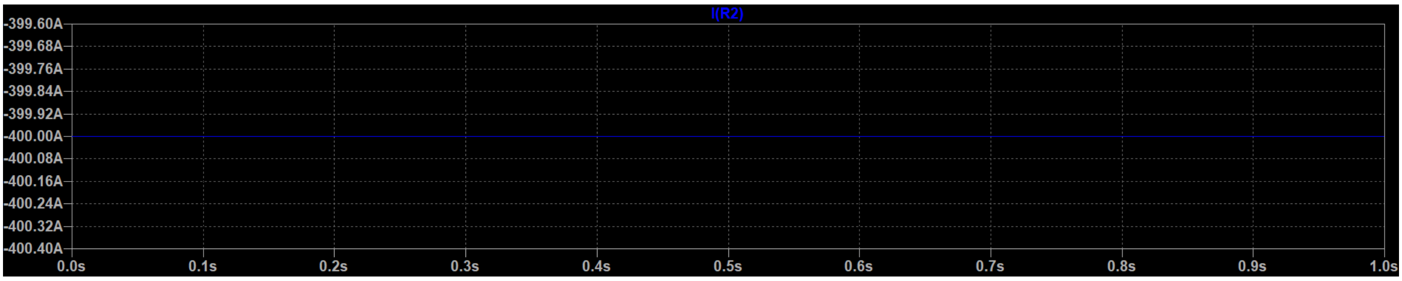
P.D. at load point B, $V_B = V_E - I_{EB} R_{EB}$

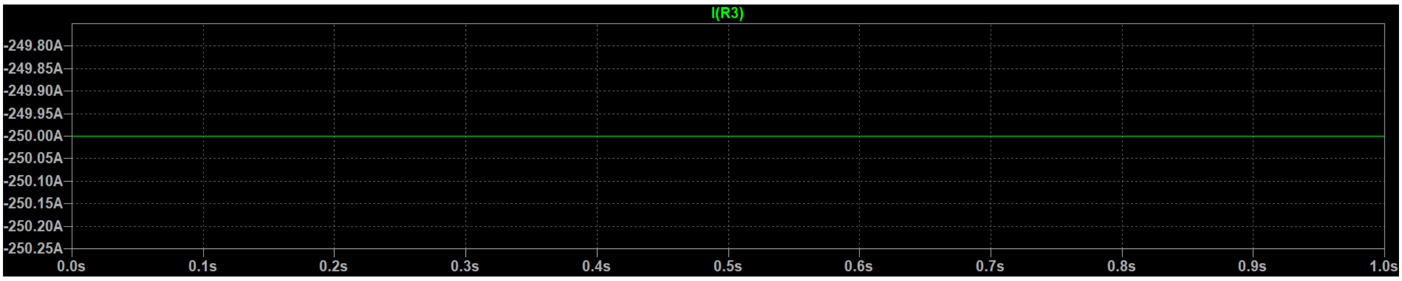
$= 288 - 50 \times 0{\cdot}008 =$ **287·6 V**

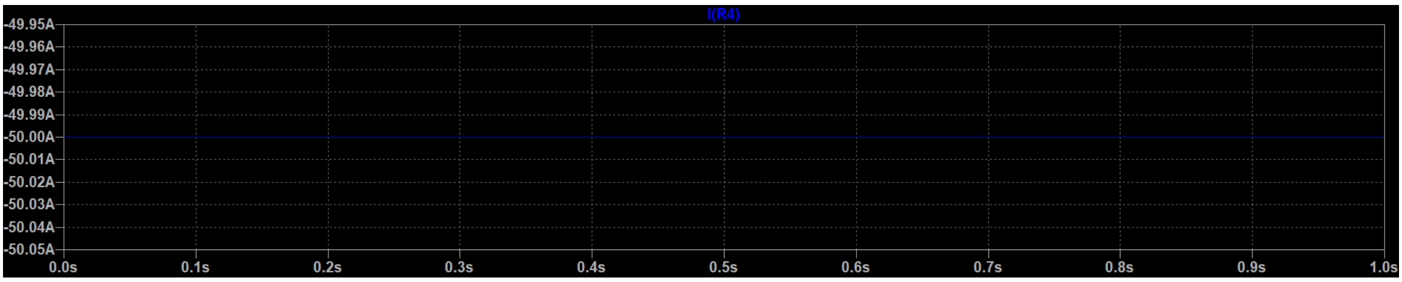
(file “DC_Single_End.asc” in the folder “LTspice_DC_distribution_systems”)

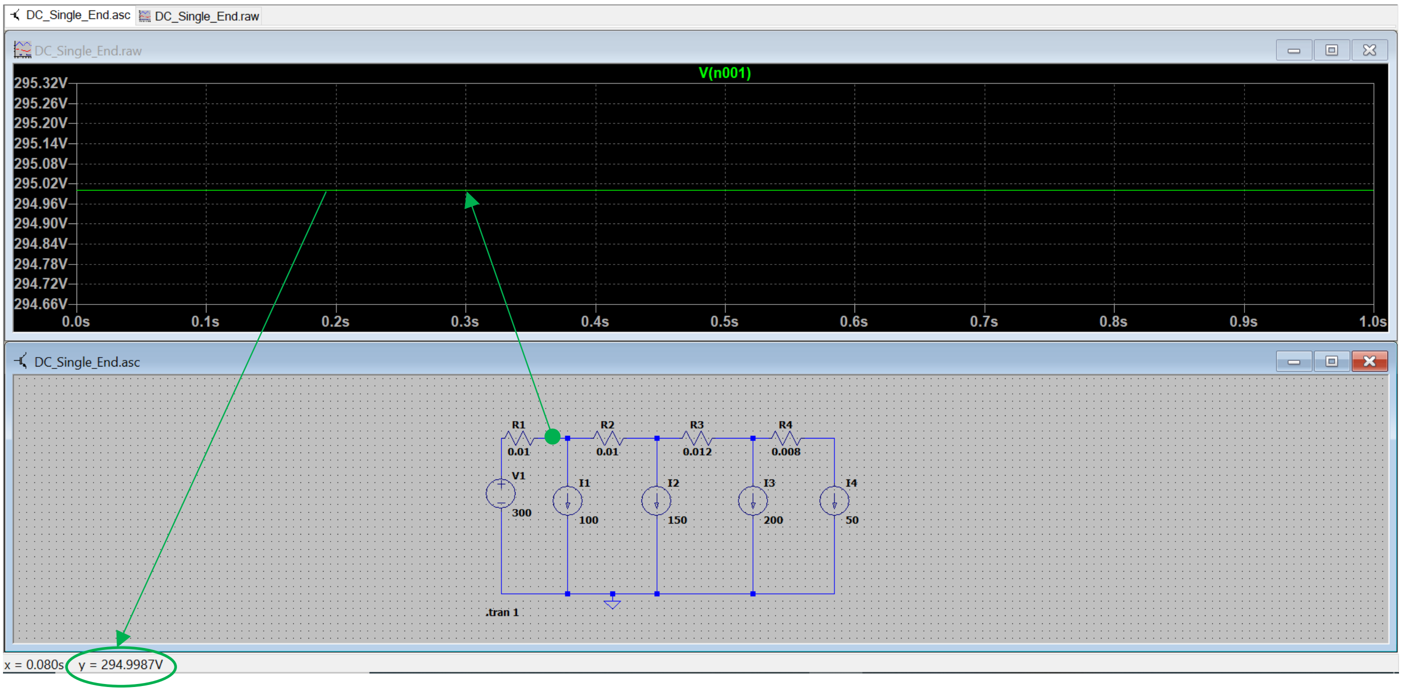


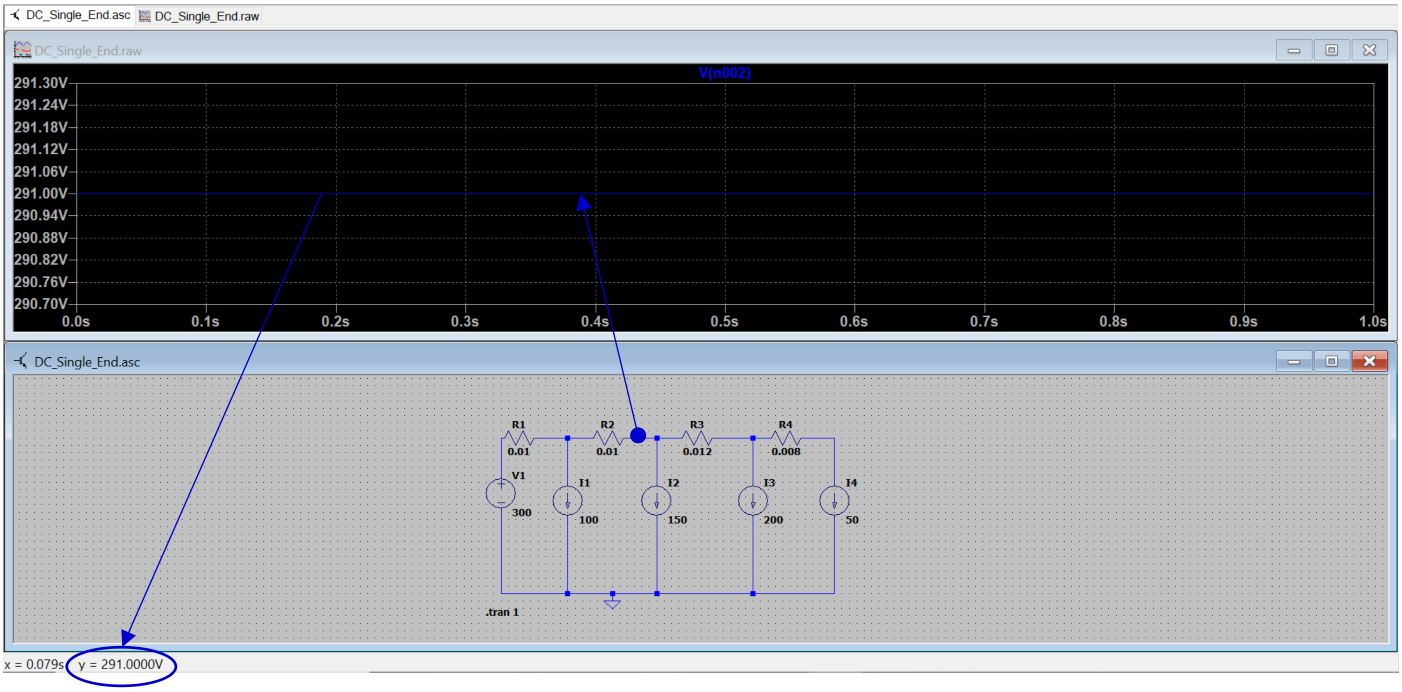


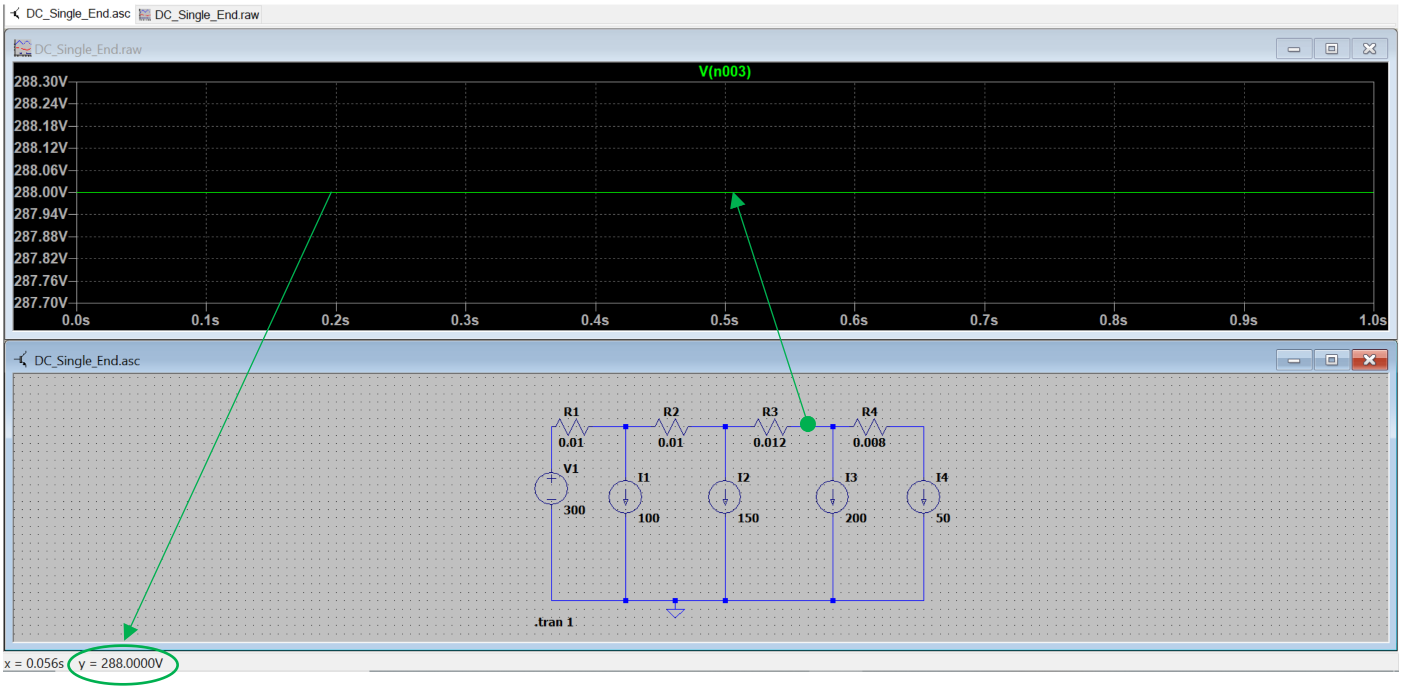


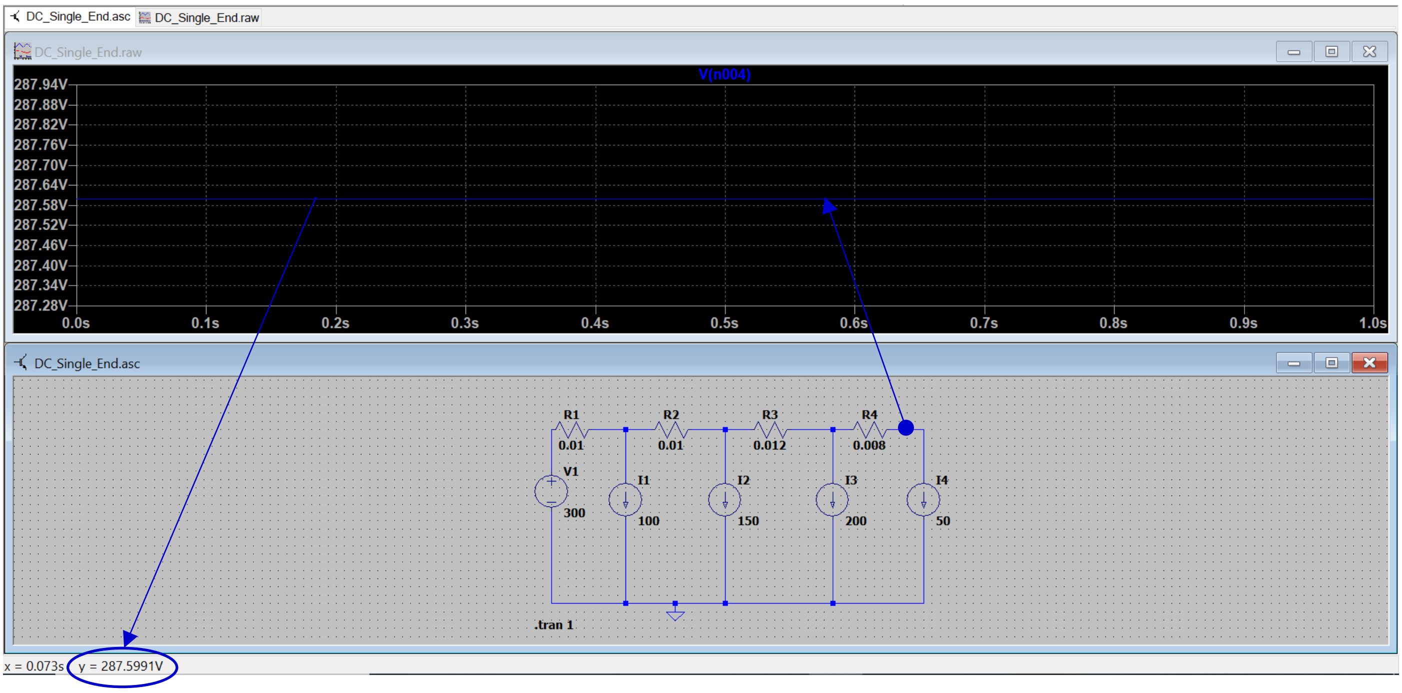





DC_Single_End.asc
DC_Single_End.raw
V(n001)
295.32V
295.26V
295.20V
295.14V
295.08V
295.02V
294.96V
294.90V
294.84V
294.78V
294.72V
294.66V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.01
R2
0.01
R3
0.012
R4
0.008
V1
300
I1
100
I2
150
I3
200
I4
50
.tran 1
x = 0.080s
y = 294.9987V


DC_Single_End.asc
DC_Single_End.raw
V(n002)
291.30V
291.24V
291.18V
291.12V
291.06V
291.00V
290.94V
290.88V
290.82V
290.76V
290.70V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.01
R2
0.01
R3
0.012
R4
0.008
V1
300
I1
100
I2
150
I3
200
I4
50
.tran 1
x = 0.079s
y = 291.0000V


DC_Single_End.asc
DC_Single_End.raw
V(n003)
288.30V
288.24V
288.18V
288.12V
288.06V
288.00V
287.94V
287.88V
287.82V
287.76V
287.70V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.01
R2
0.01
R3
0.012
R4
0.008
V1
300
I1
100
I2
150
I3
200
I4
50
.tran 1
x = 0.056s
y = 288.0000V


DC_Single_End.asc
DC_Single_End.raw
V(n004)
287.94V
287.88V
287.82V
287.76V
287.70V
287.64V
287.58V
287.52V
287.46V
287.40V
287.34V
287.28V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.01
R2
0.01
R3
0.012
R4
0.008
V1
300
I1
100
I2
150
I3
200
I4
50
.tran 1
x = 0.073s
y = 287.5991V

Task:

A 2-wire d.c. ring distributor is 300 m long and is fed with 240 V at point A. At point B, 150 m from A, a load of 120 A is taken and at C, 100 m in the opposite direction, a load of 80 A is taken. If the resistance per 100 m of single conductor is 0·03 Ω, find : (i) current in each section of distributor (ii) voltage at points B and C .

Solution.

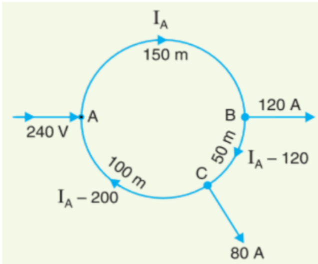
Resistance per 100 m of distributor

$$= 2 \times 0{\cdot}03 = 0{\cdot}06\ \Omega$$

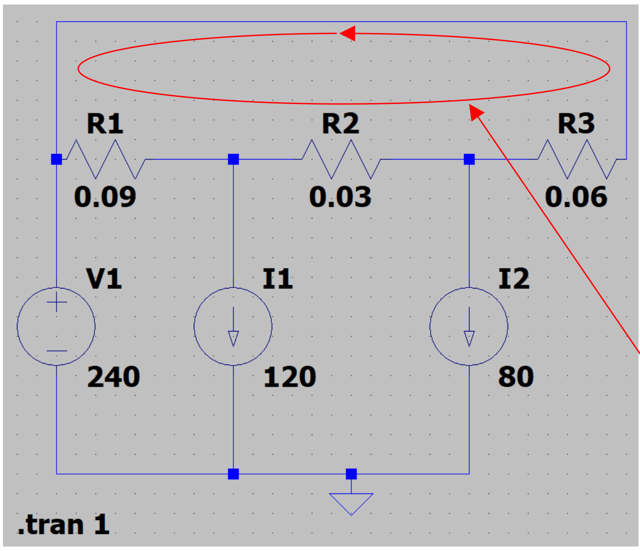
Resistance of section AB, R_{AB} $= 0{\cdot}06 \times 150/100 = 0{\cdot}09\ \Omega$

Resistance of section BC, R_{BC} $= 0{\cdot}06 \times 50/100 = 0{\cdot}03\ \Omega$

Resistance of section CA, R_{CA} $= 0{\cdot}06 \times 100/100 = 0{\cdot}06\ \Omega$



(file "DC_Ring_1.asc" in the folder "LTspice_DC_distribution_systems")



Let us assume that current I_A flows in section AB of the distributor. Then currents in sections BC and CA will be (I_A − 120) and (I_A − 200) respectively as shown in the Figure above.

According to Kirchhoff's voltage law, the voltage drop in the closed loop ABCA is zero i.e.

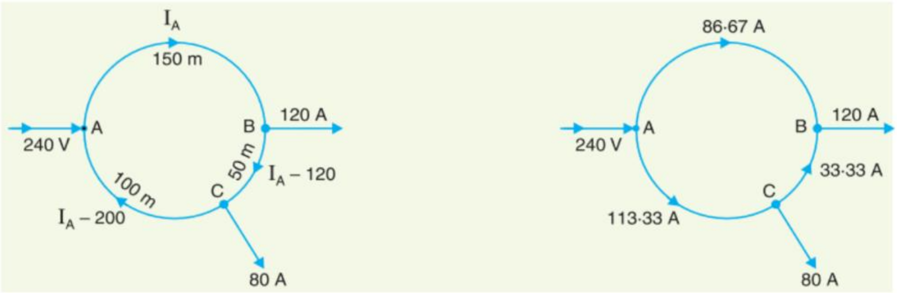
$$I_{AB} R_{AB} + I_{BC} R_{BC} + I_{CA} R_{CA} = 0$$

or $$0{\cdot}09\, I_A + 0{\cdot}03\,(I_A - 120) + 0{\cdot}06\,(I_A - 200) = 0$$

or $$0{\cdot}18\, I_A = 15{\cdot}6$$

$\therefore$ $$I_A = 15{\cdot}6/0{\cdot}18 = 86{\cdot}67\text{ A}$$

The actual distribution of currents is as shown in Figure below from where it is seen that B is the point of minimum potential.



Current in section $AB, I_{AB} = I_A = \mathbf{86{\cdot}67\ A}$ *from A to B*

Current in section $BC, I_{BC} = I_A - 120 = 86{\cdot}67 - 120 = -33{\cdot}33$ A

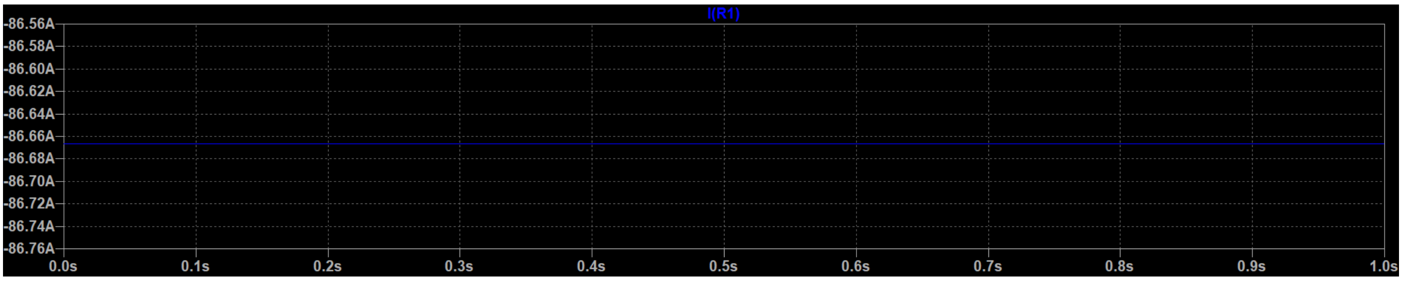
$= \mathbf{33.33\ A}$ *from C to B*

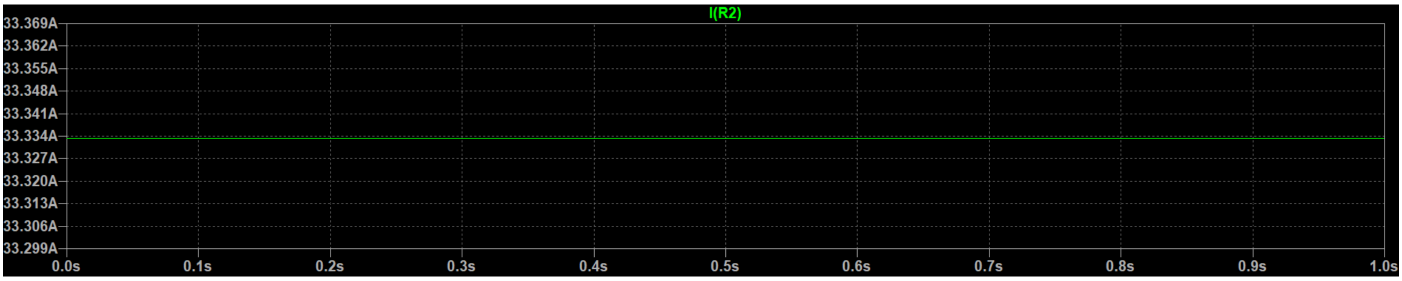
Current in section $CA, I_{CA} = I_A - 200 = 86{\cdot}67 - 200 = -113{\cdot}33$ A

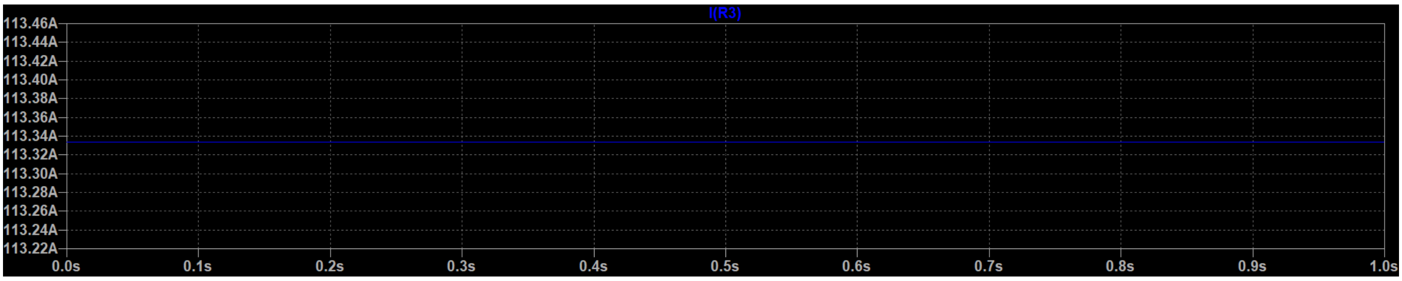
$= \mathbf{113{\cdot}33\ A}$ *from A to C*

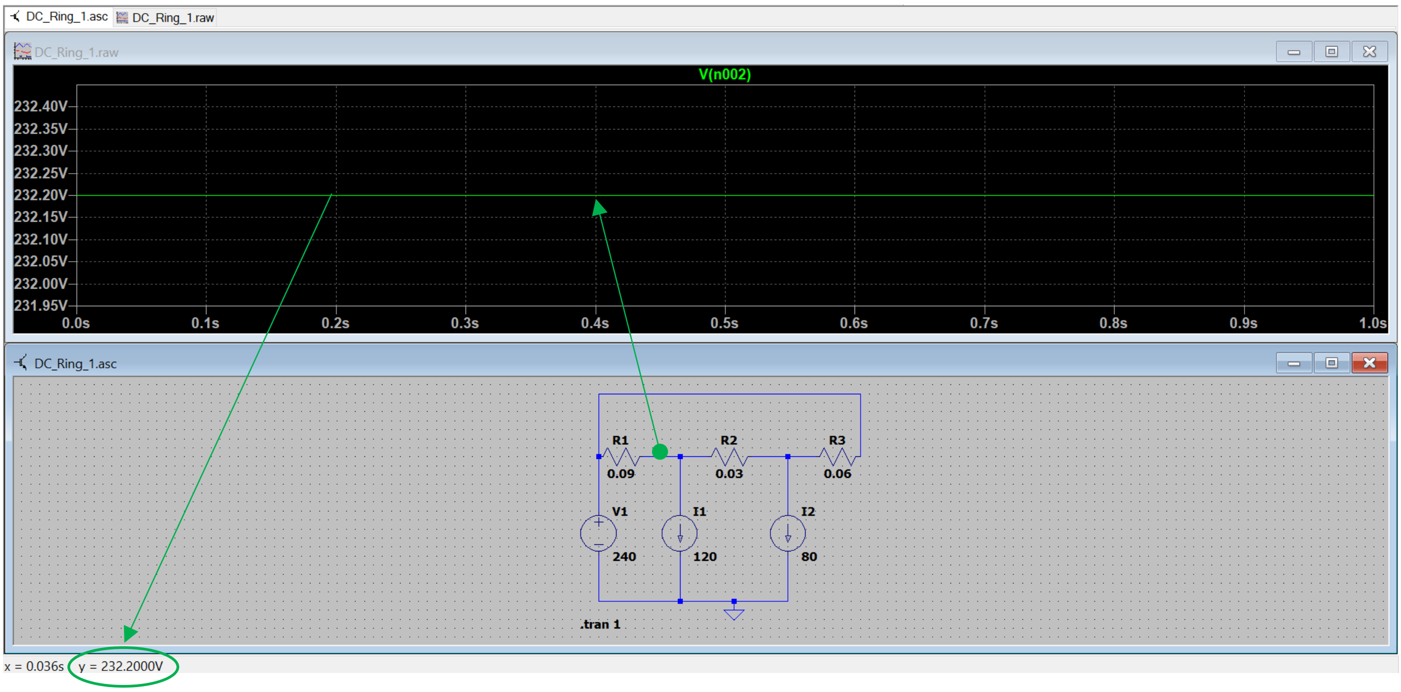
(*ii*) Voltage at point $B, V_B = V_A - I_{AB} R_{AB} = 240 - 86{\cdot}67 \times 0{\cdot}09 = \mathbf{232{\cdot}2\ V}$

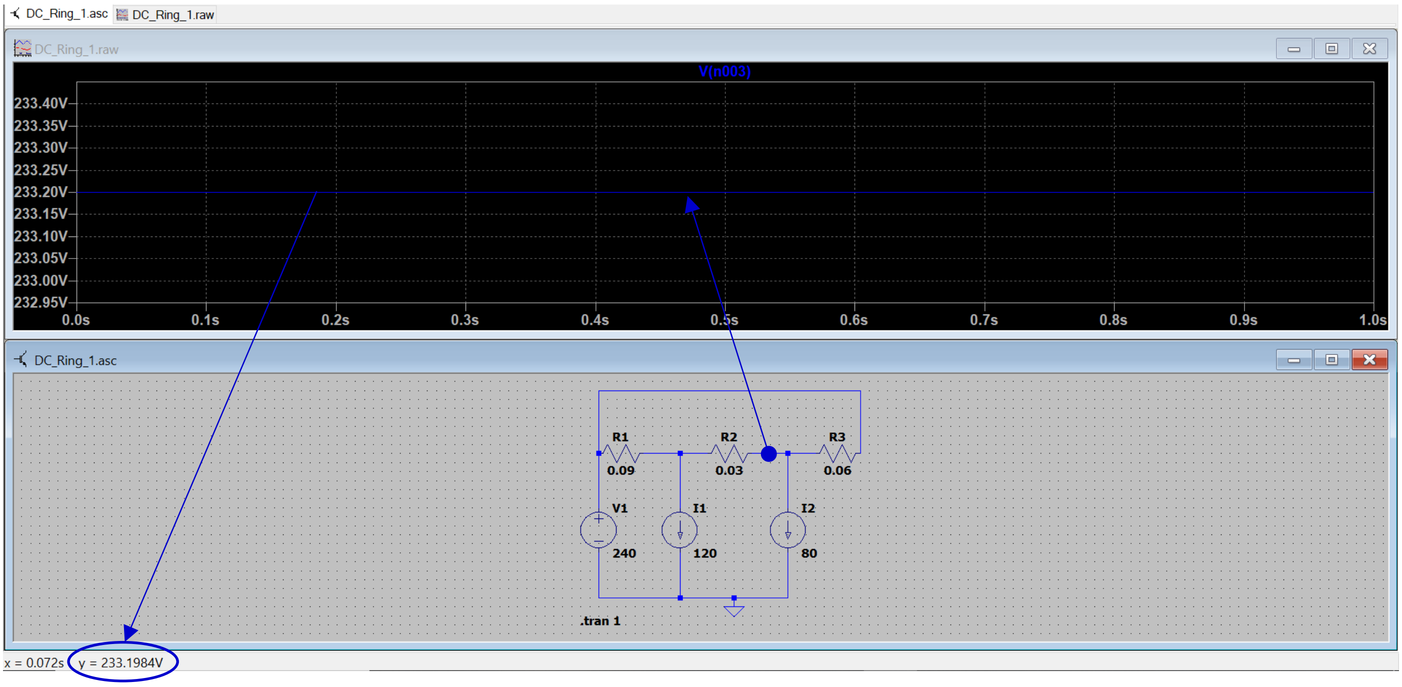
$$\text{Voltage at point } C, V_C = V_B + I_{BC} R_{BC} = 232{\cdot}2 + 33{\cdot}33 \times 0{\cdot}03 = \mathbf{233{\cdot}2\ V}$$







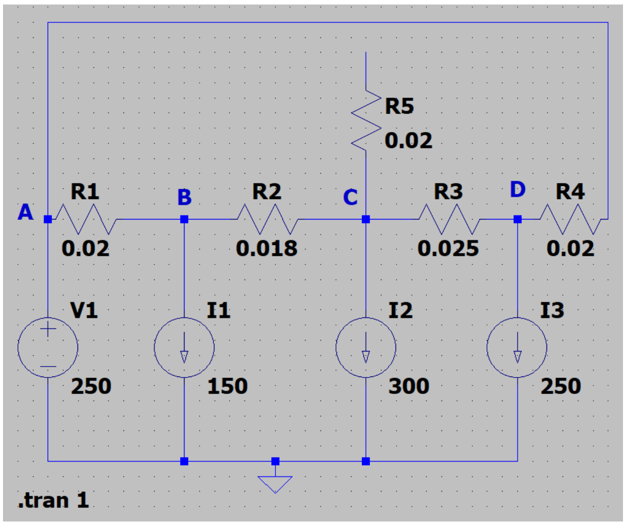

DC_Ring_1.asc
DC_Ring_1.raw
V(n002)
232.40V
232.35V
232.30V
232.25V
232.20V
232.15V
232.10V
232.05V
232.00V
231.95V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.09
R2
0.03
R3
0.06
V1
240
I1
120
I2
80
.tran 1
x = 0.036s
y = 232.2000V

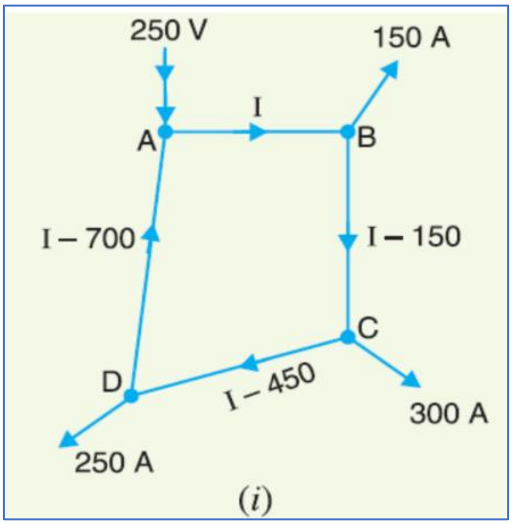

DC_Ring_1.asc
DC_Ring_1.raw
V(n003)
233.40V
233.35V
233.30V
233.25V
233.20V
233.15V
233.10V
233.05V
233.00V
232.95V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R1
0.09
R2
0.03
R3
0.06
V1
240
I1
120
I2
80
.tran 1
x = 0.072s
y = 233.1984V

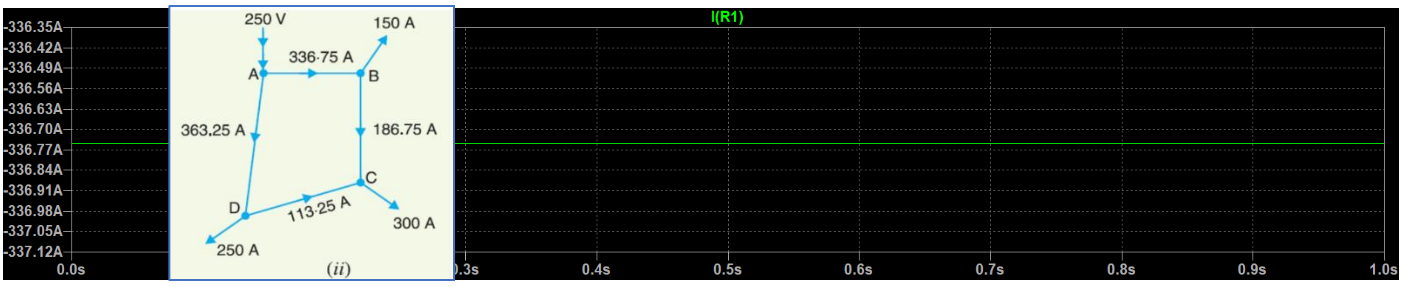
Task:

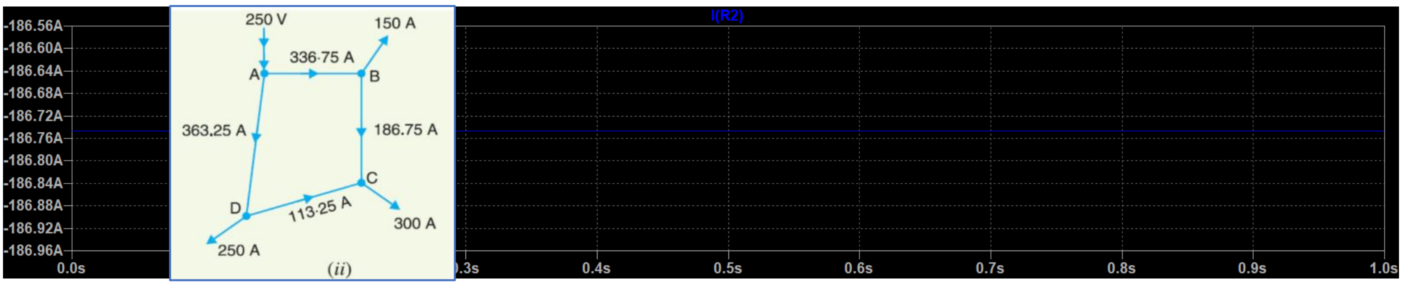
A d.c. ring main ABCDA is fed from point A from a 250 V supply and the resistances (including both lead and return) of various sections are as follows : AB = 0·02 Ω ; BC = 0·018 Ω ; CD = 0·025 Ω and DA = 0·02 Ω. The main supplies loads of 150 A at B ; 300 A at C and 250 A at D. Determine the voltage at each load point. If the points A and C are linked through an interconnector of resistance 0·02Ω, determine the new voltage at each load point.

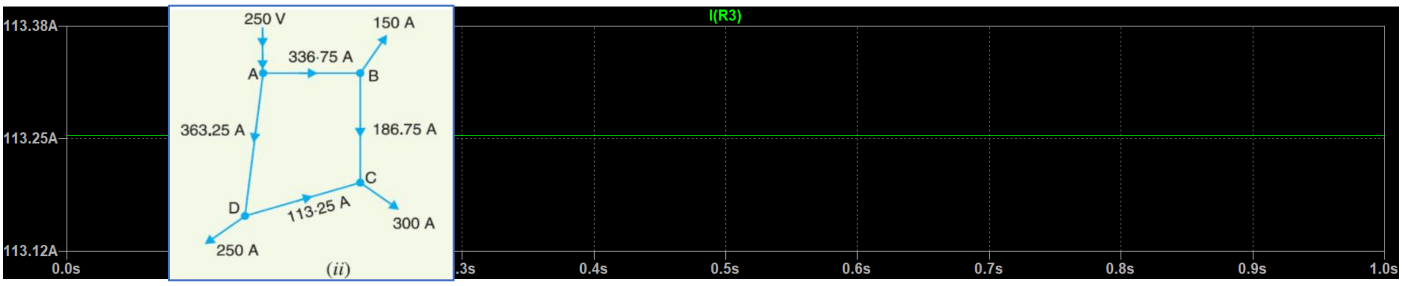
(file “DC_Ring_2.asc” in the folder “LTspice_DC_distribution_systems”)

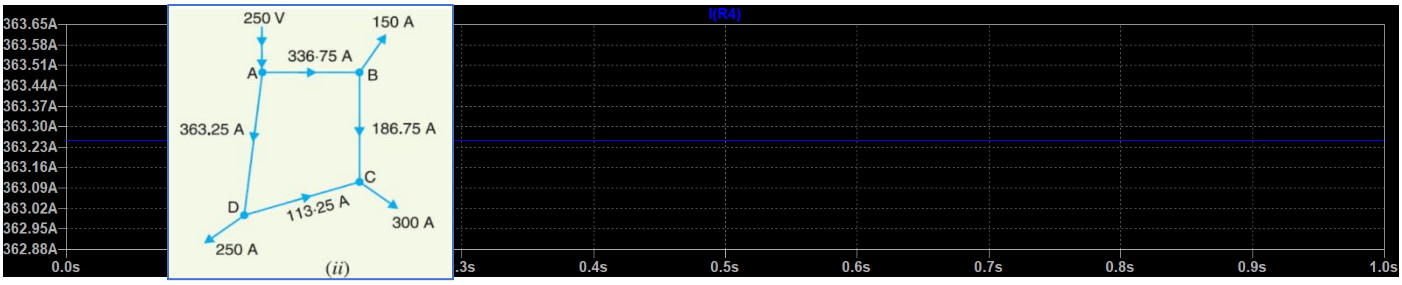




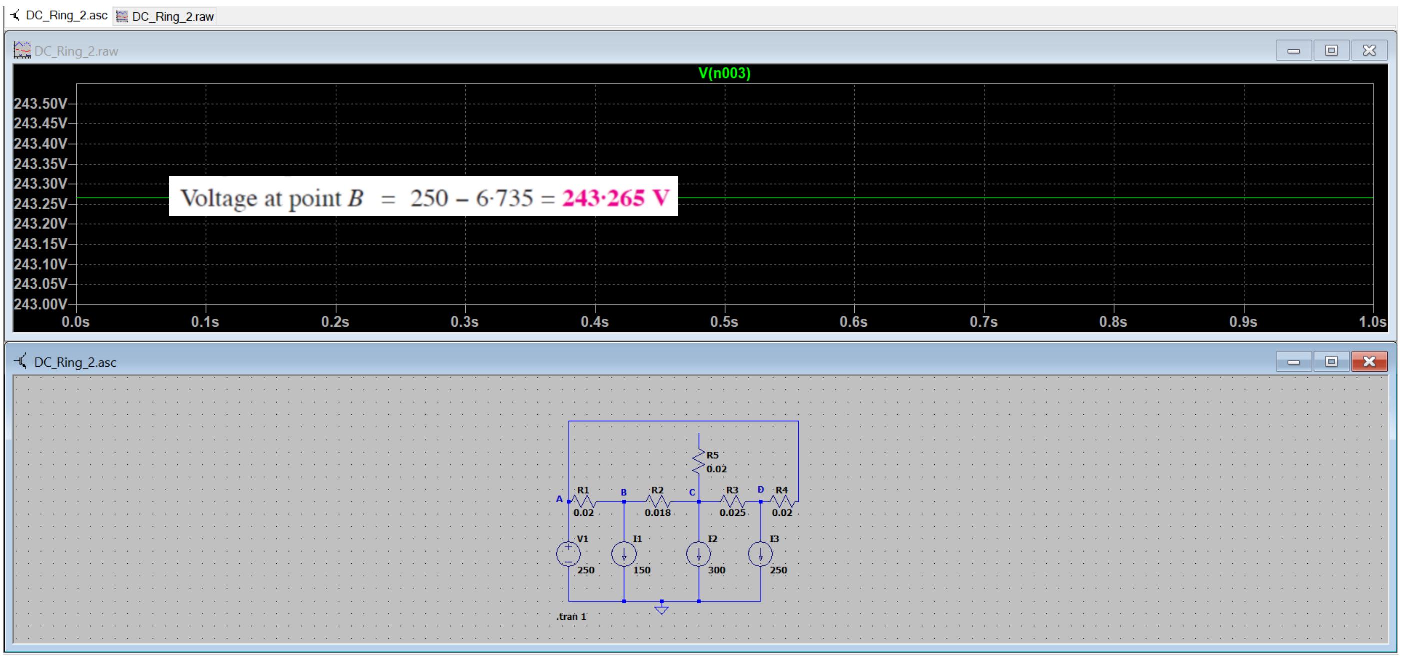


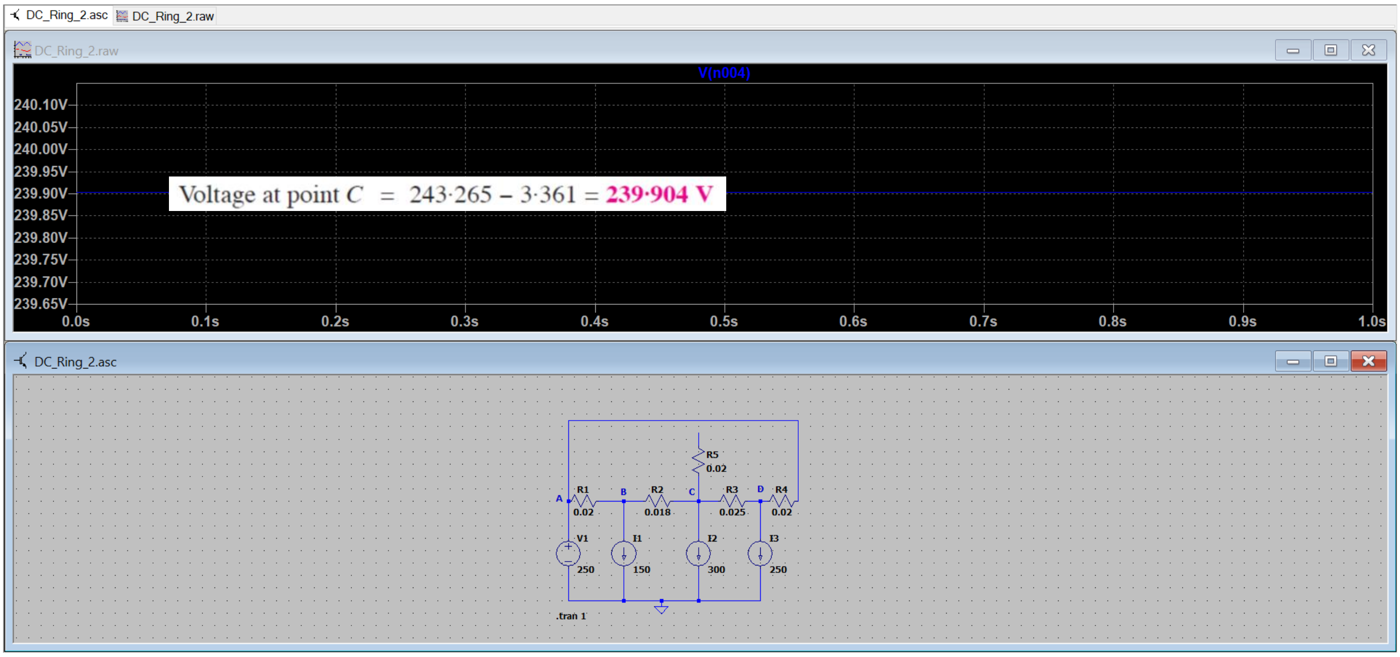


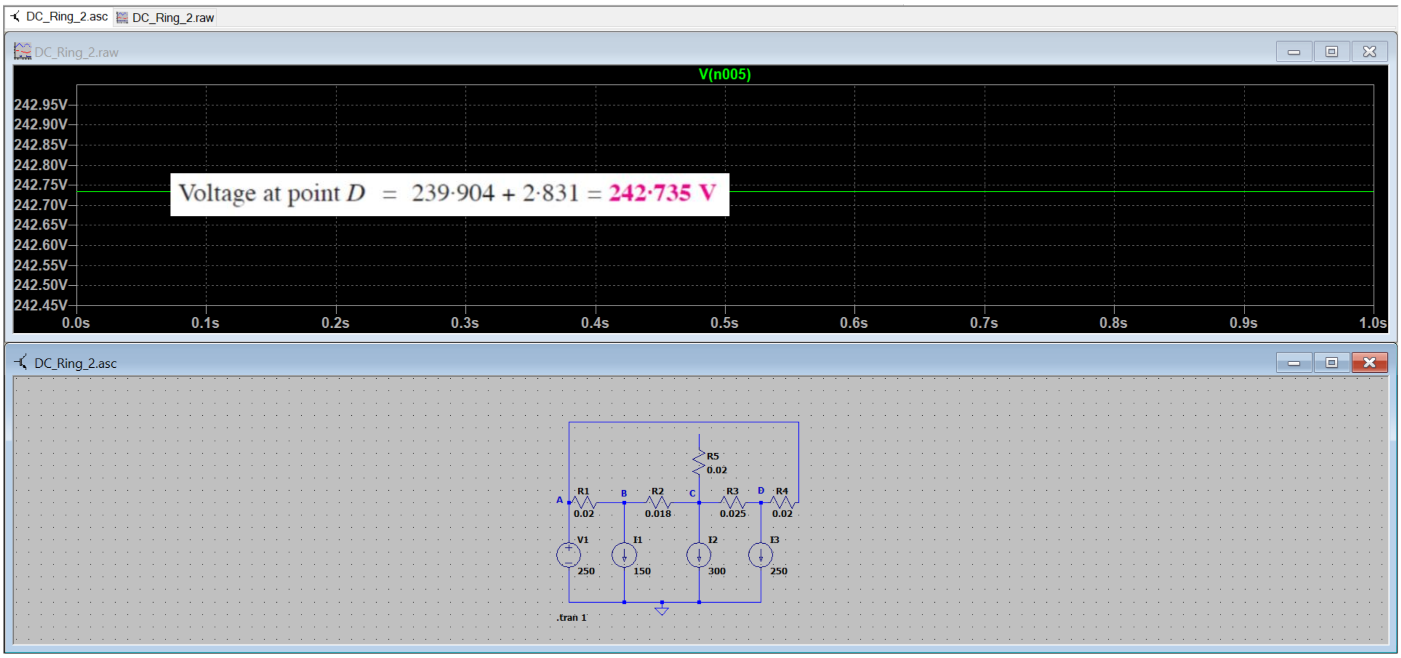


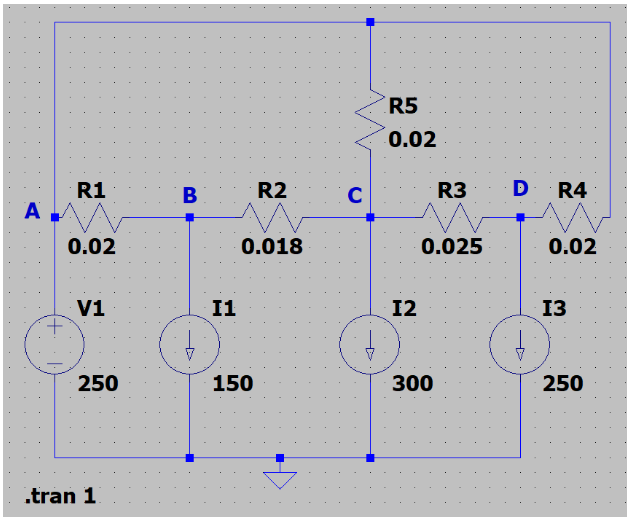


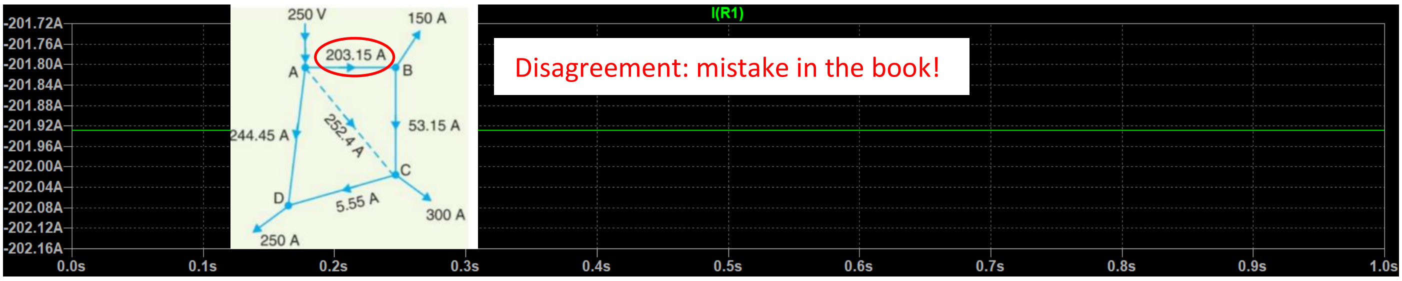
$$\begin{aligned}
\text{Voltage drop in } AB &= 336{\cdot}75 \times 0{\cdot}02 = 6{\cdot}735 \text{ V} \\
\text{Voltage drop in } BC &= 186{\cdot}75 \times 0{\cdot}018 = 3{\cdot}361 \text{ V} \\
\text{Voltage drop in } CD &= 113{\cdot}25 \times 0{\cdot}025 = 2{\cdot}831 \text{ V} \\
\text{Voltage drop in } DA &= 363{\cdot}25 \times 0{\cdot}02 = 7{\cdot}265 \text{ V} \\
\text{Voltage at point } B &= 250 - 6{\cdot}735 = \mathbf{243{\cdot}265 \text{ V}} \\
\text{Voltage at point } C &= 243{\cdot}265 - 3{\cdot}361 = \mathbf{239{\cdot}904 \text{ V}} \\
\text{Voltage at point } D &= 239{\cdot}904 + 2{\cdot}831 = \mathbf{242{\cdot}735 \text{ V}}
\end{aligned}$$

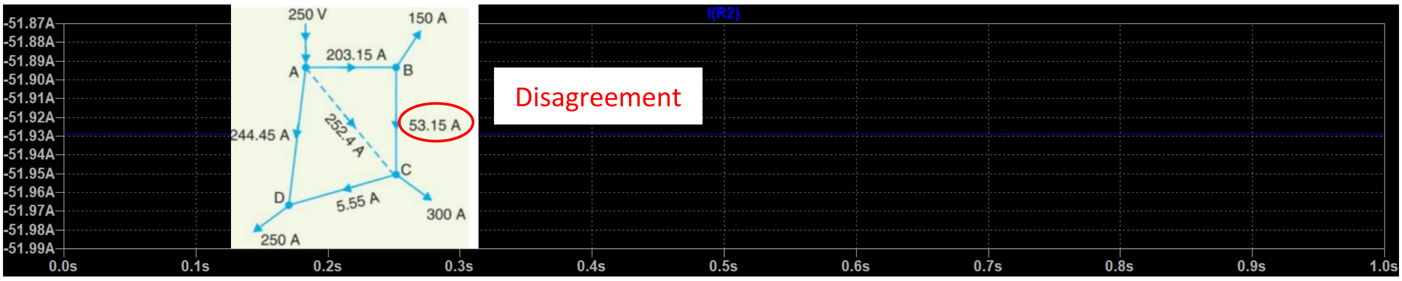


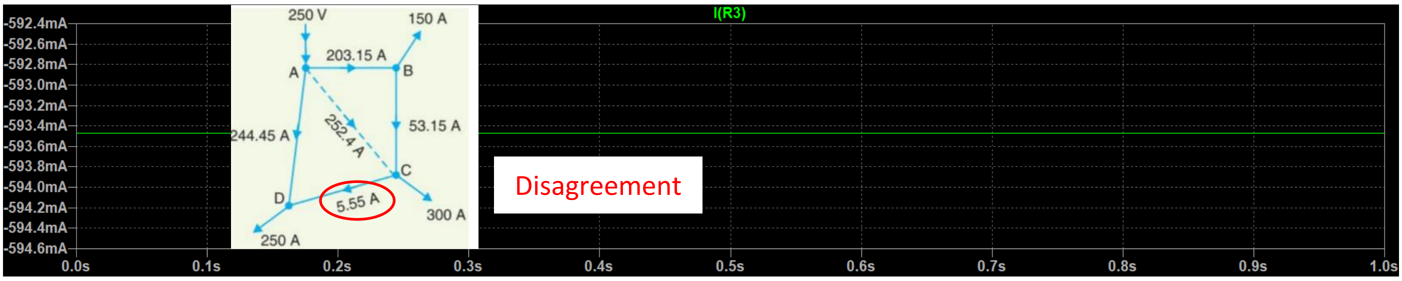

DC_Ring_2.asc
DC_Ring_2.raw
V(n004)
Voltage at point C = 243·265 – 3·361 = 239·904 V
240.10V
240.05V
240.00V
239.95V
239.90V
239.85V
239.80V
239.75V
239.70V
239.65V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R5
0.02
A
R1
0.02
B
R2
0.018
C
R3
0.025
D
R4
0.02
V1
250
I1
150
I2
300
I3
250
.tran 1

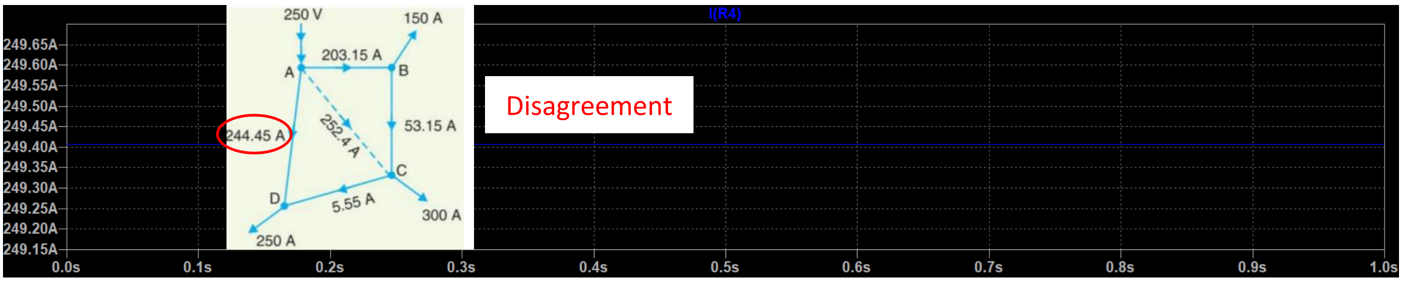

DC_Ring_2.asc
DC_Ring_2.raw
V(n005)
Voltage at point D = 239·904 + 2·831 = 242·735 V
242.95V
242.90V
242.85V
242.80V
242.75V
242.70V
242.65V
242.60V
242.55V
242.50V
242.45V
0.0s
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s
R5
0.02
A
R1
0.02
B
R2
0.018
C
R3
0.025
D
R4
0.02
V1
250
I1
150
I2
300
I3
250
.tran 1

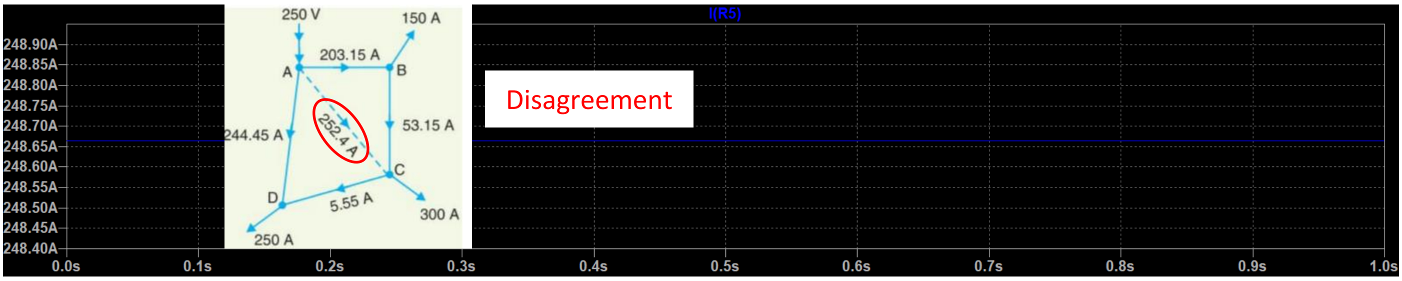

R5
0.02
A
R1
0.02
B
R2
0.018
C
R3
0.025
D
R4
0.02
V1
250
I1
150
I2
300
I3
250
.tran 1


I(R1)
Disagreement: mistake in the book!

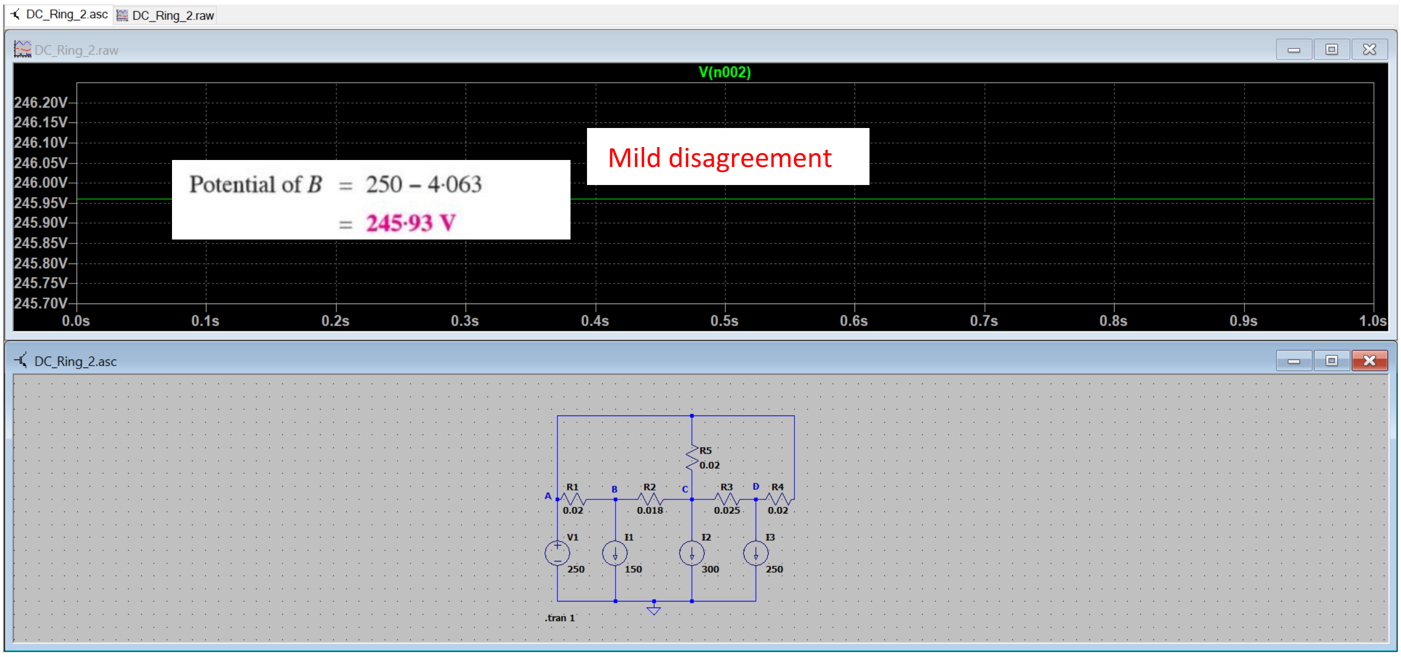

I(R2)
Disagreement

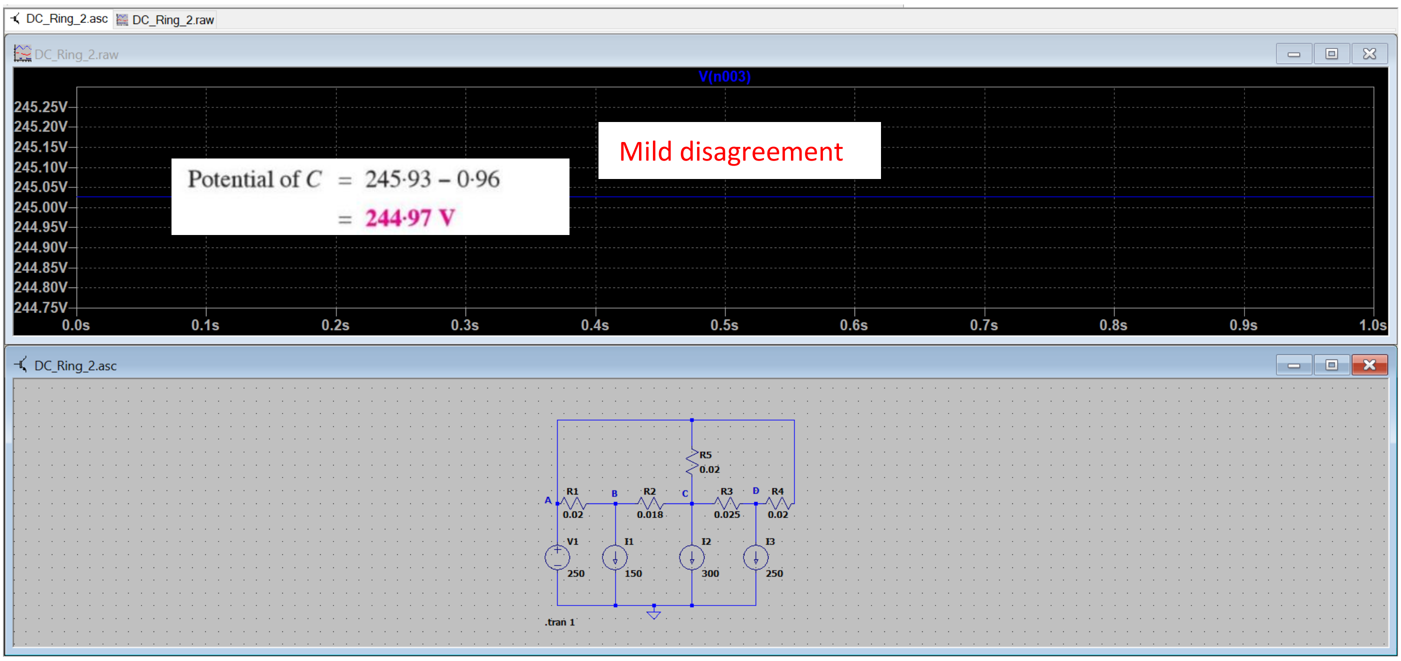

I(R3)
Disagreement

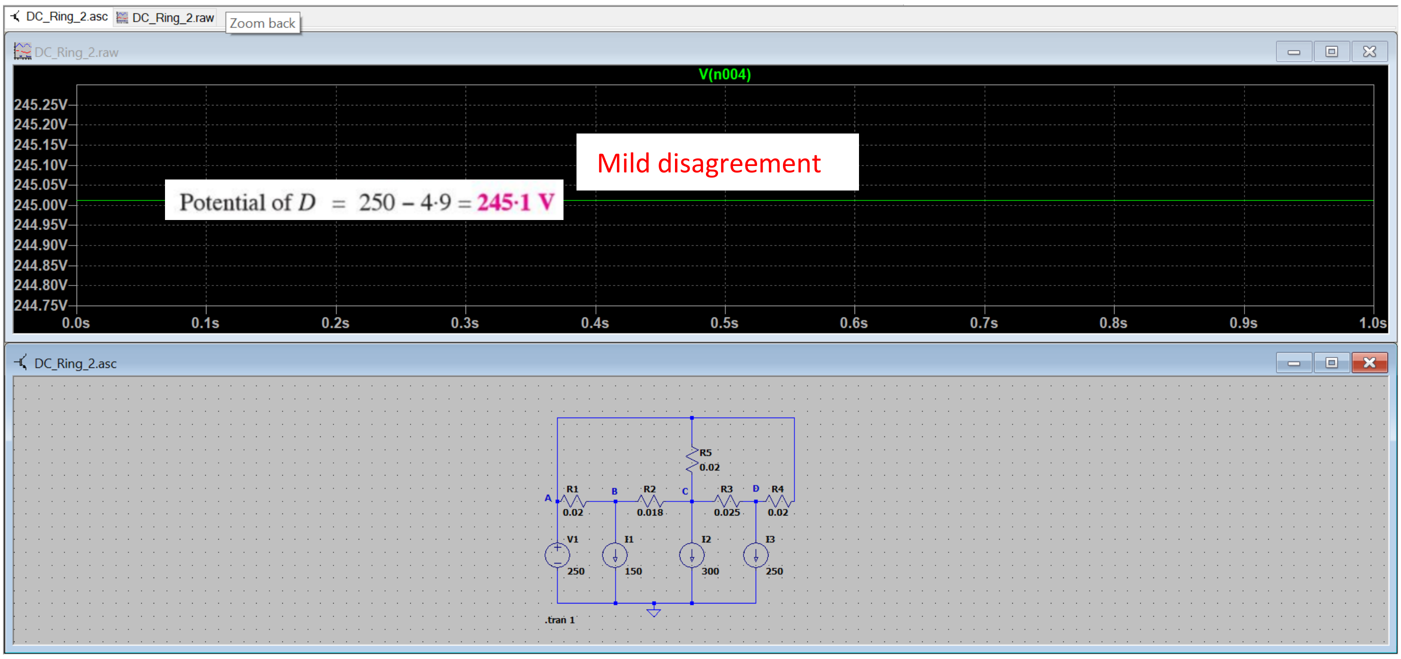

I(R4)
Disagreement



This task serves as a clear demonstration that more complex calculations can easily lead to errors when done manually. Therefore, it's advisable to promptly turn to simulations, especially considering their easy accessibility, to ensure accuracy in such cases.

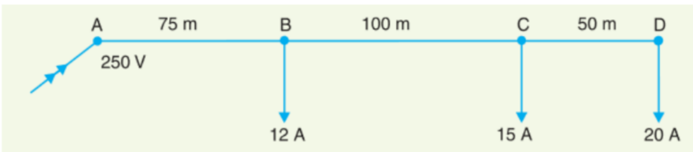


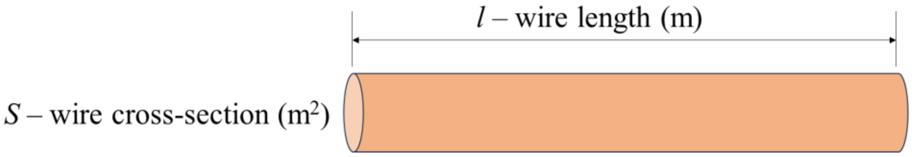




Try LTspice simulator at home for the following task:

The load distribution on a two-wire d.c. distributor is as shown below. The cross-sectional area of each conductor is 0·27cm^2. The end A is supplied at 250 V. Resistivity of the wire is ρ = 1·78 μΩcm. Calculate (i) the current in each section of the conductor (ii) the two-core resistance of each section (iii) the voltage at each tapping point.





$$R_l = \rho \frac{l}{S} \text{ – resistance of the wire } (\Omega)$$

ρ – resistivity (Ω×m)

When calculating $R_l = \rho \frac{l}{S}$, transfer all units to the main SI units:

$S = 0.27 \text{ cm}^2 \rightarrow S = 0.27 \times 0.01 \times 0.01 = \mathbf{2.7 \times 10^{-5}\ m^2}$ (1 cm = 0.01 m)

$\rho = 1.78\ \mu\Omega \times \text{cm} \rightarrow \rho = 1.78 \times 10^{-6}\Omega \times 0.01 \text{ m} = \mathbf{1.78 \times 10^{-8}\Omega \times m}$ (copper resistivity)

$R_l = \rho \frac{l}{S} = \frac{1.78\times10^{-8}}{2.7\times10^{-5}} \times l = \frac{1.78\times10^{-3}}{2.7} \times l \approx \mathbf{6.66 \times 10^{-4} \times \mathit{l}}$ (length in meters)