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EXPERIMENT III CIRCUIT ANALYSIS TECHNIQUES, PRACTICAL SUPPLIES and MAXIMUM POWER TRANSFER

EQUIPMENT LIST:

DC Power Supply

Multimeter

Resistors (100Ω, 2 x 1kΩ, 2.2kΩ, 3.3kΩ, 6.8kΩ, 8.2kΩ, 1k pot)

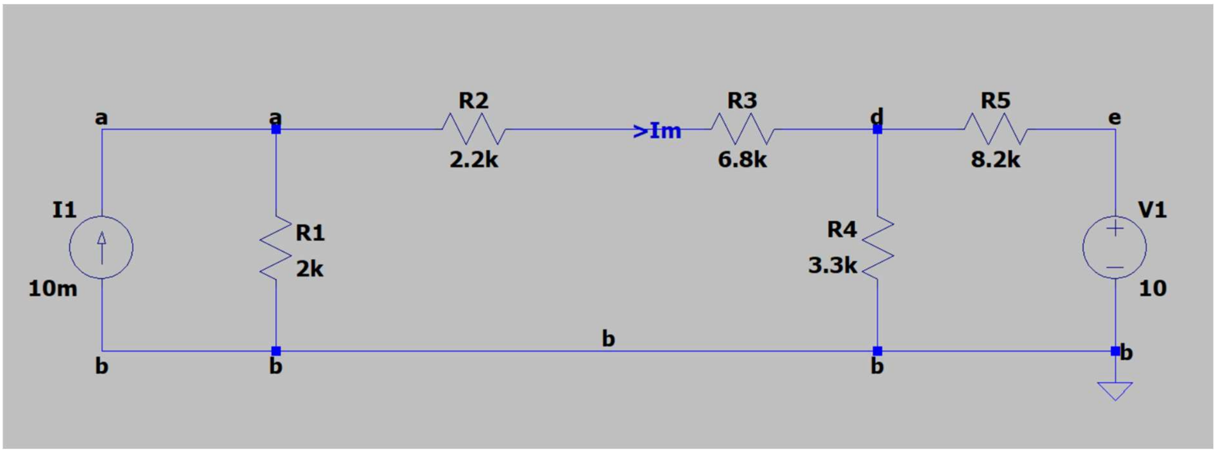
PRELIMINARY WORK:

Introduction:

In this prework we will study the nodal analysis in curcuits, Thevenin and Norton Equivalents, practical(real) sources and maximum power transfer.

QUESTION 1. Node voltage, Thevenin and Norton transformation techniques:

A)



Applying KLC at node a we get:
-I1+(Va/R1)+[(Va-Vd)/(R2+R3)]=0
10mA=(Va/2) + (Va-Vd)/9
10mA=(9Va+2Va -2Vd)/18
10mA*18=180A=11Va-2Vb

Applying KLC at node d we get:
[(Va-Vd)/R2+R3]+[(V1-Vd)/R5]-Vd/R4=0
Vd/3.3=(Va-Vd)/9 + (10-Vd)/8.2
73.8Vd=(27.06Va-27.06Vd)+(297-29.7Vd)
130.56Vd-27.06Va=297

By solving the 2 equations:
130.56Vd-27.06Va=297
11Va-2Vd=180→718.08Va-130.56Vd=11750.4
691.02Va=12047.4

Va=17.43 V

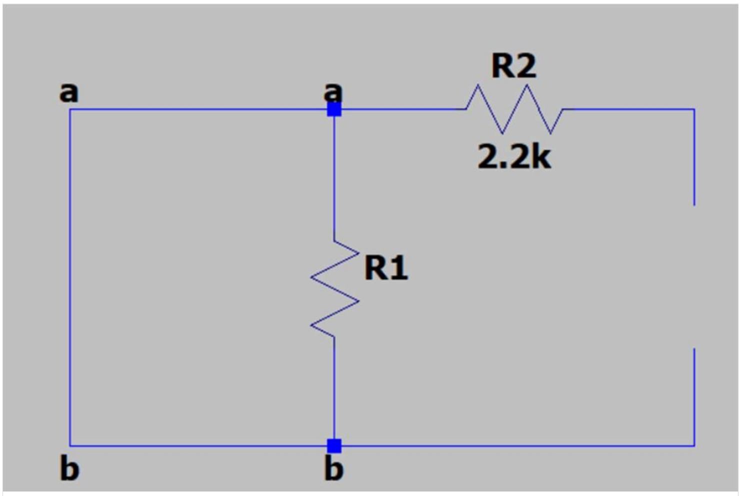
By putting Va in the first equation: Vd=5.865V

Then Im=(Va-Vd)/(R2+R3)

Im=(17.43-5.865)/9=11.565/9=1.285A

Vm=Va-Im*R2= 17.43-(2.2*1.285)=14.603V

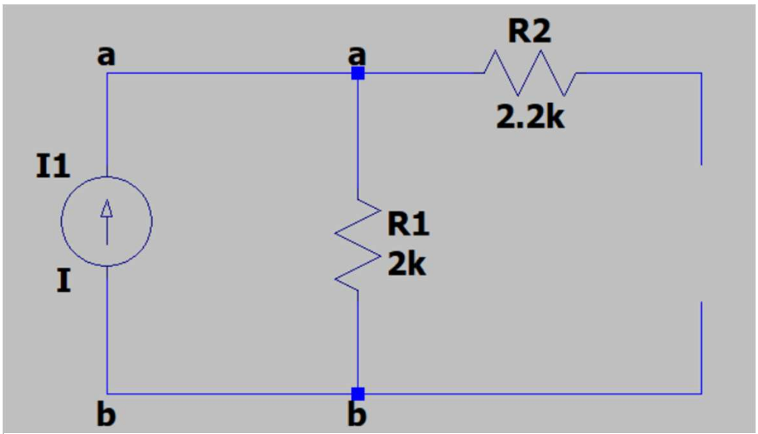
B) To derive the thevenin equivalent for the portion of the circuit to the left of vm terminals we need Rth and Vth.



1 Short Curcuit

By killing the source and making the curcuit as an short curcuit we found the Req:

Req=2.2kΩ=Rth

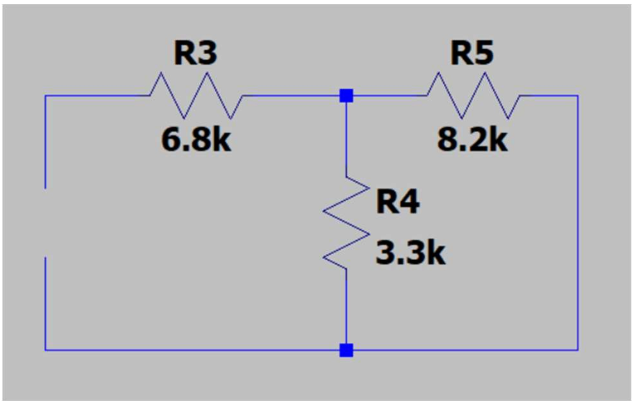


2 Open Curcuit

By making the curcuit as an open curcuit we found the Vth:

Vth=I1*R1= 10mA*2kΩ=20V

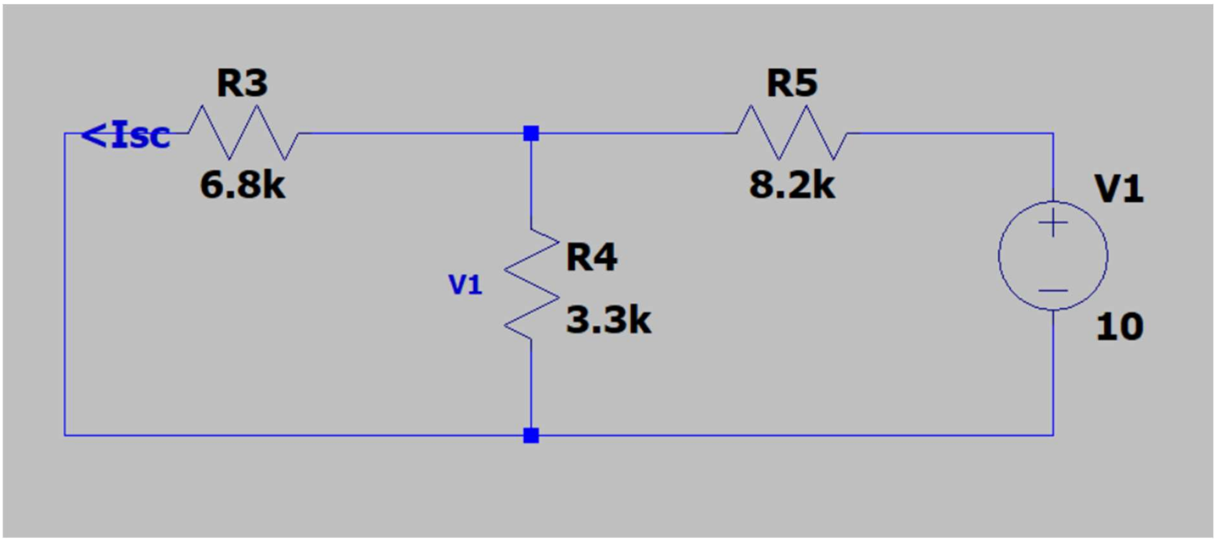
C) To derive the Norton equivalent t for the portion of the circuit that is to the right of vm terminals we need Rn and In.



By killing the source we found Rn:

Rn=R3+(R5||R4)=6.8+[(8.2*3.3)/(8.2+3.3)] = 6.8+2.35 = 9.15 kΩ

By creating a short curcuit:



Req=(R3||R4)+R5=[(6.8*3.3)/(6.8+3.3)]+8.2=2.22+8.2=10.42

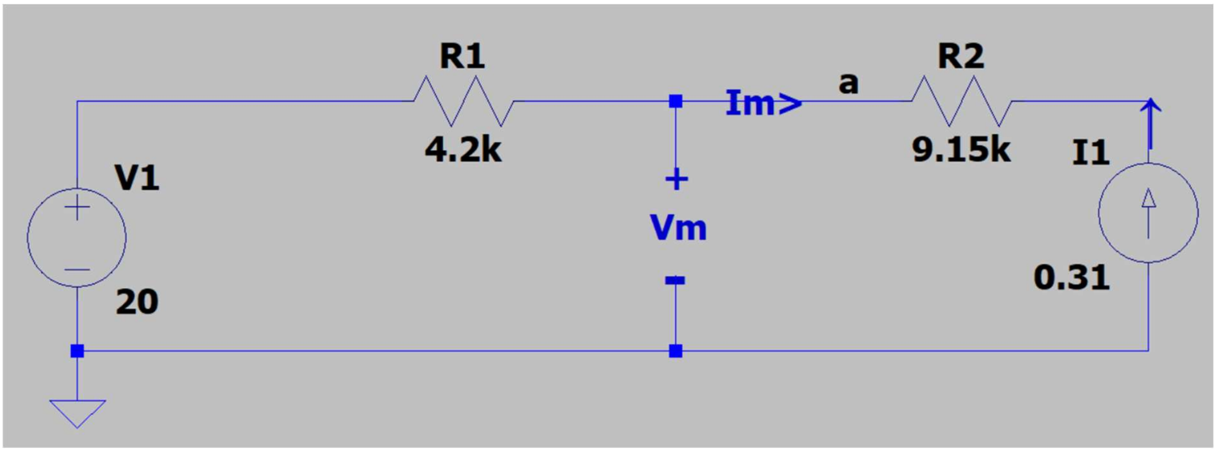
V=I*Req→10=I*10.42

I=0.96A

Isc=In=I*3.3/(6.8+3.3)=(0.96)*(3.3)/(10.1)=0.31A

Rth=Voc/Isc=20/0.31=64.5

D)



E)

V1 = 20 V

V = I * R ; V = 0.31*9.15=2.84 V (for right side)

Im = (V1-2.84)/R1 =(20-14.6)/4.2=1.29A

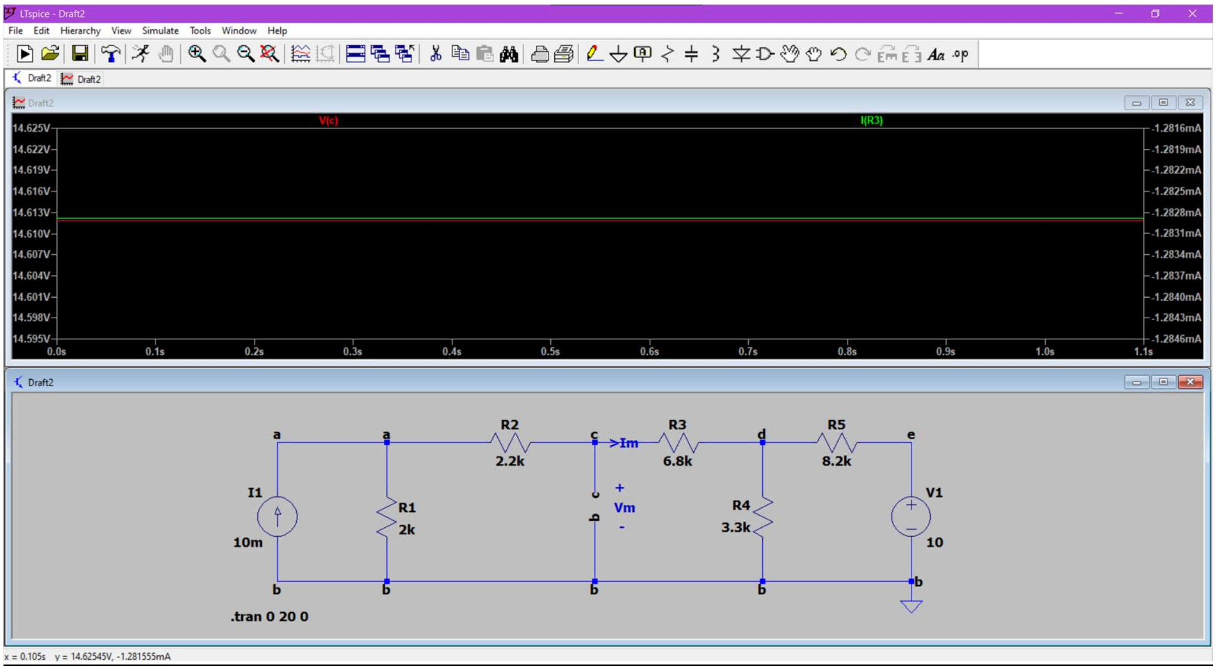
For Vm: (20-Vm)/4.2=1.29

20-Vm=1.29*4.2

Vm=14.582 V

These values are consistent with the values we found at (a). We simplify the curcuit by applying Thevenin and Norton transformation techniques and calculate the unknowns. Since we didn't change the curcuit the founded values didn't change at the end.

F)



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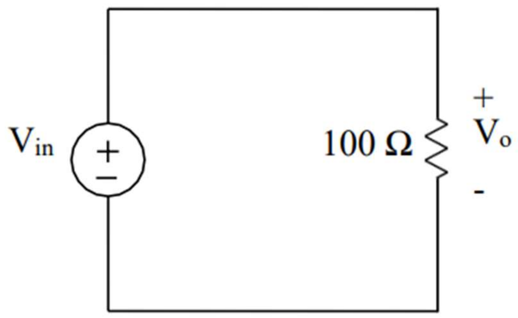
--- Operating Point ---

V(a):	17.4342	voltage
V(c):	14.6119	voltage
V(d):	5.88825	voltage
V(n001):	10	voltage
I(I1):	0.01	device_current
I(R1):	0.00871711	device_current
I(R2):	-0.00128289	device_current
I(R3):	-0.00128289	device_current
I(R4):	-0.00178432	device_current
I(R5):	-0.000501433	device_current
I(V1):	-0.000501433	device_current

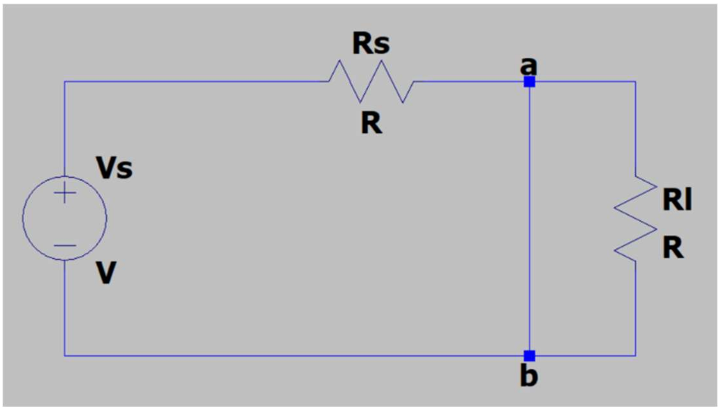
QUESTION 2. Real (practical) power supplies and maximum power transfer

A)

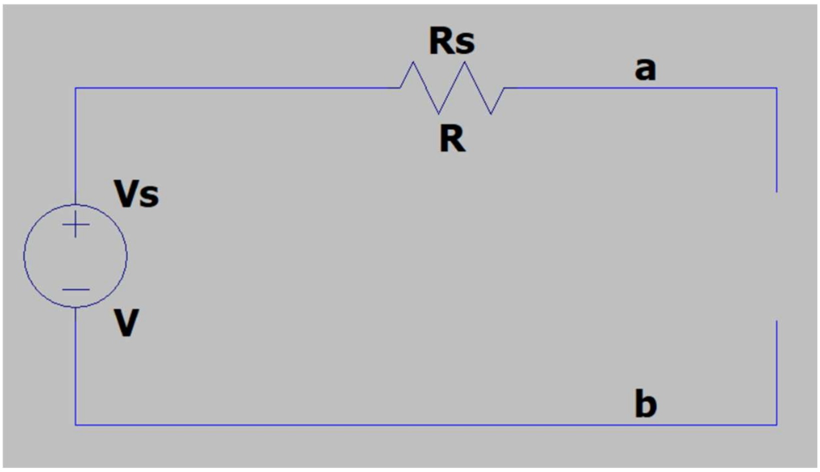


No, Vin and Vo don't have same value. Because in reality there are always resistive drops due to voltage resistance and cable resistance.

B) When a- b connected with a wire, we create a short curcuit. And by the information we know that the current measured between node a and b is 50 mA. This value is equal to Is.



When RL is disconnected from the curcuit we create an open-curcuit. And by the information we know that between a and b the voltage is 5V. This voltage equal to Vs. Therefore Vs=5V



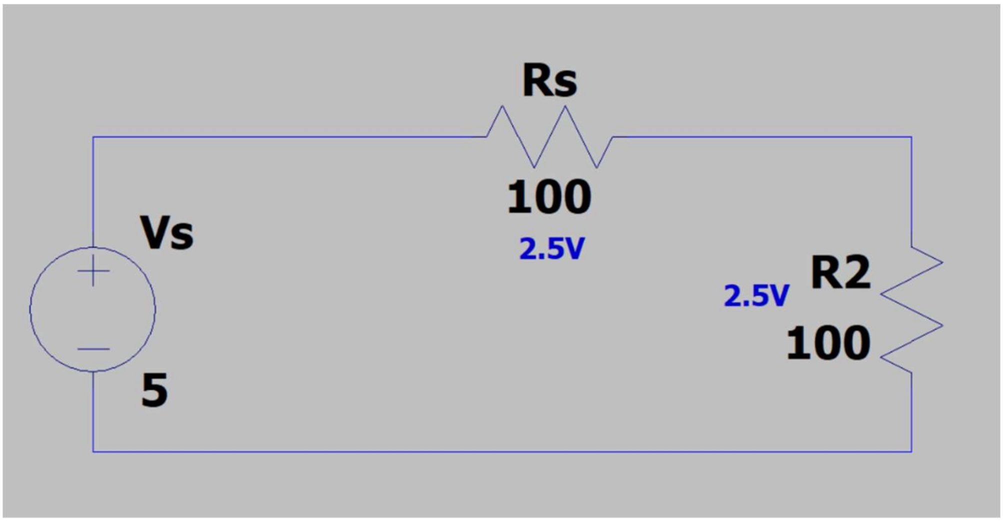
Also, Rs = Vs/Is = 5/0.05 = 100 ohm

B)

When max power transfered: R(Load) = Rs, therefore

R(Load) = 100 ohm

C)

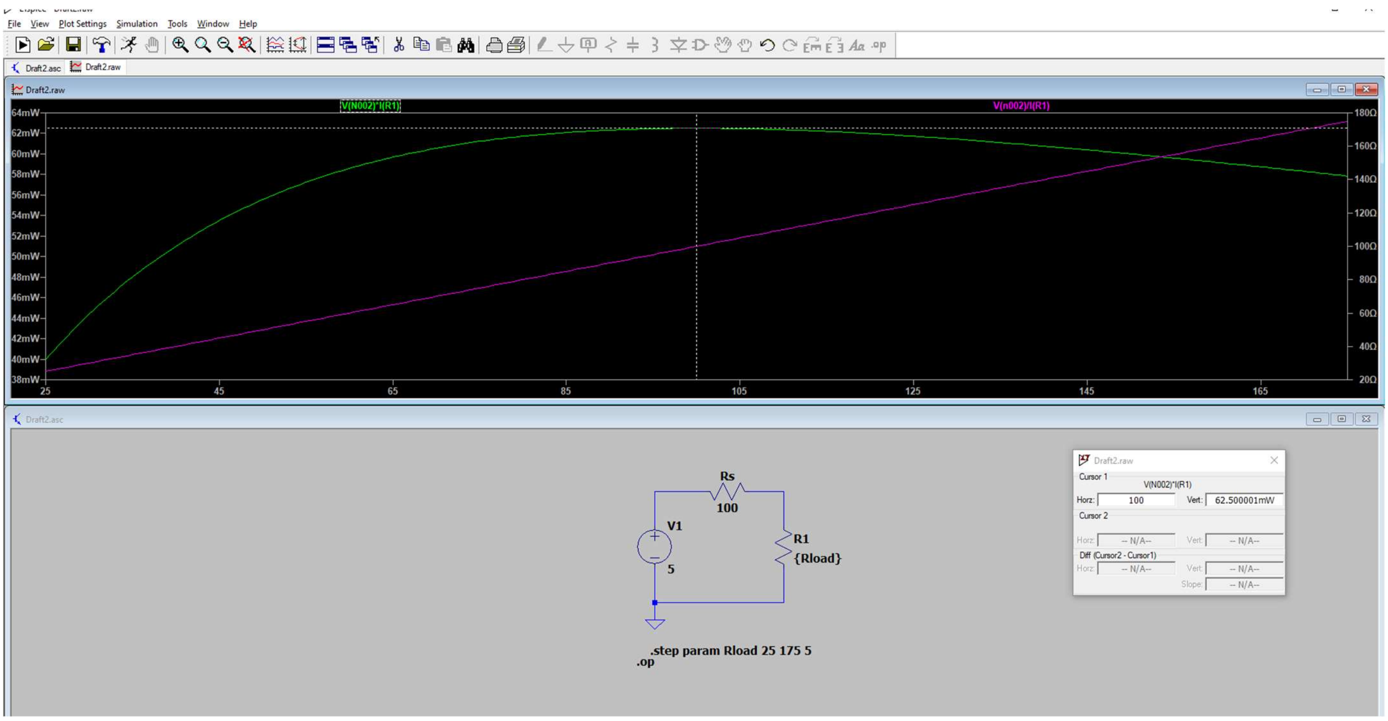


V=I*R

5=I*(100+100)

P=[(2.5)^2]/100=0.0625W

D)



Conclusion:

We studied the nodal analysis in curcuits and find the unknown values by KVL and KCL equations for each reference nodes.

We used Thevenin and Norton Equivalents to simplify the curcuit and calculate the same unknowns by KVL and KCL. They initially have the same values because the curcuit remains the same.

We studied the differences between practical and theoretical sources and understand that with the same curcuit the values differentiate due to voltage resistance and cable resistance.

We used LTSpice to find when circuit uses max. power.