SARKAR, Mohul

Experiment Number 4

Node Equations

TUESDAY

March 19

ECE 1101L

Spring 2024

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Lab:

ECE 1101L Experiment 4

NODE EQUATIONS

OBJECTIVES

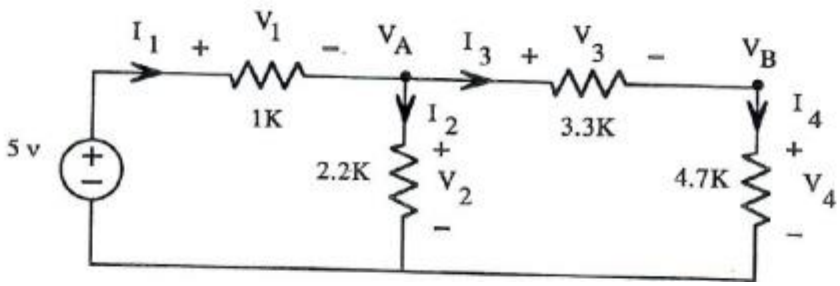
-Learn how to write node equations

MATERIALS REQUIRED BY STUDENT

-11 clip leads

-Required Resistors

Pre-Lab:



1.

a. Node A: V_a-5/1k + V_a-V_b/3.3K + V_a/2.2k=0
   Node B: V_b/4.7k + V_b-V_a/3.3k=0

b.

$$A = \begin{bmatrix} 1276 & -220 \\ -47 & 50 \end{bmatrix}$$

c. V_a=3.395V
   V_b=3.191V

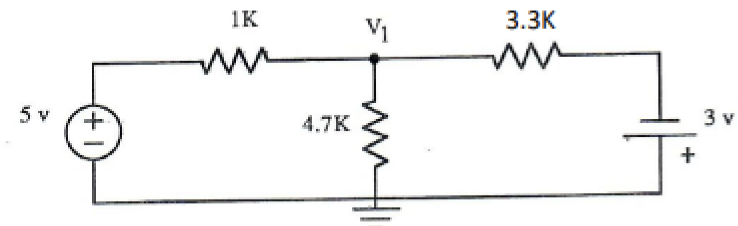
d. V_1=5V(1k/1k+2.2k) = 1.56 V
   I_1=1.83 mA
   V_2= 5V(2.2k/1k+2.2k) = 3.4375 V
   I_2=3.4375 V/ 2.2 k = 1.56 mA

V_3= 3.395 V (3.3k/3.3k+4,7k) =1.4 V

I_3= I_1-I_2= 1.83-1.56= 0.27 mA

V_4= V_a-V_b=3.191-1.4=1.8 V

I_4= 3.191/4.7= 0.68 mA

2. 

Node voltage at V1: 2.69 V

Node equations:

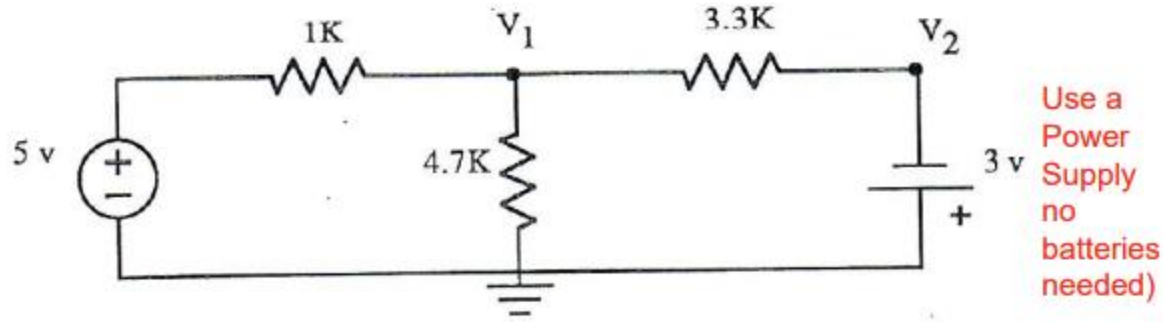
V_1-5/1k + V_1+3/3.3k + V_1/4.7K = 0

V_1/1k + V_1/3.3k + V_1/4.7k = 4.09

V_1(1/3.3 + 1/4.7) = 4.09

V_1= 2.69 V

Given CKT1:



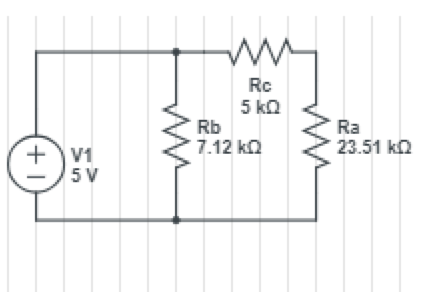
		Branch Voltages			
Ref Des	Voltage Across Element [V]	Branch Equation	Measured Branch Voltage [V]	Calculated Branch Values [V]	Equivalent Resistance [Ω]
V_1	2.5	$V_1 - 5$	-2.4	-2.4	5.69k
V_2	-2.95	V_1+V_2	5.4	5.4	
		V_1	2.6	2.6	
		$V_1 - 3$	-5.4	-5.4	

Equivalent resistance:

R_a= 3.3k +3.3k*4.7k + 4.7k = 23.51k

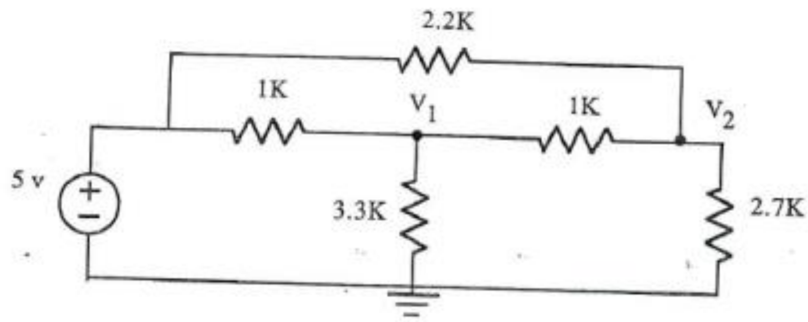
R_b= (3.3k + 3.3k*4.7k + 4.7k)/3.3k= 7.12k

R_c= (3.3k + 3.3k*4.7k + 4.7k)/4.7k = 5k



R_{eq}= 5.69k

Given CKT2:



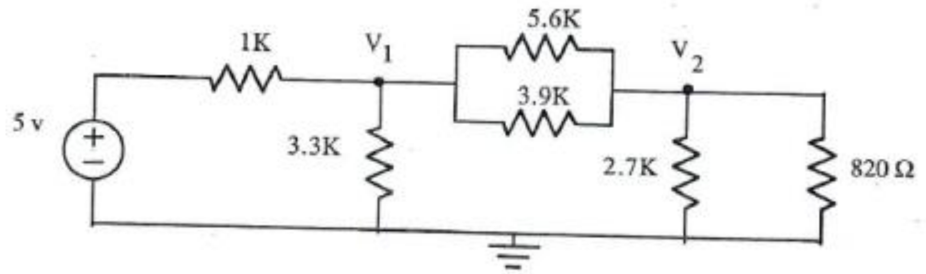
		Branch Voltages			
Ref Des	Voltage Across Element [V]	Branch Equation	Measured Branch Current [mA]	Calculated Branch Current [mA]	Equivalent Resistance [Ω]
V_1	3.3	$V_1 – V_2/1k$	0.26	0.3	2.79k
V_2	3	$V_1 – 5/1k$	-1.34	-1.7	
		$V_1/3.3k$	1	1	
		$V_2/2.7k$	1.1	1.11	
		$V_2 – 5/2.2k$	-0.7	-0.9	

R_{eq1}= (1/2k + 1/2.2k)^-1 = 1.048

R_{eq2}= (1/3.3k +1/2.7k)^-1 = 1.74

$R_{eqfinal}$= 1.048 + 1.74 = 2.788k

Given CKT3:



		Branch Voltages				
Ref Des	Voltage Across Element [V]	Branch Equation	Ref Des	Measured Branch Current [mA]	Calculated Branch Current [mA]	Equivalent Resistance [Ω]
V_1	3	$V_1 – 5/1k$	I_1	3	3	2.54k
V_2	0.64	$V_1/3.3k$	I_2	0.87	0.91	
$V1_{R1(left)}$	3	$V_1/2.3k$	I_3	1.28	1.3	
$V1_{R2(down)}$	2.871	$V_2/2.3k$	I_4	0.25	0.28	
$V1_{R3(right)}$	2.944	$V_2/ 0.82k$	I_5	0.78	-0.9	
$V2_{R1(right)}$	0.639	$V_2/2.7k$	I_6	0.21	0.24	
$V2_{R2(down)}$	0.567					
$V2_{R3(left)}$	0.575					

R_{eq1}= (1/5.6k + 1/3.9k)^-1= 2.3k

R_{eq2}= (1/2.7k + 1/0.82k)^-1= 0.628k

R_{eq3}= 2.3k + 0.628k = 2.9k

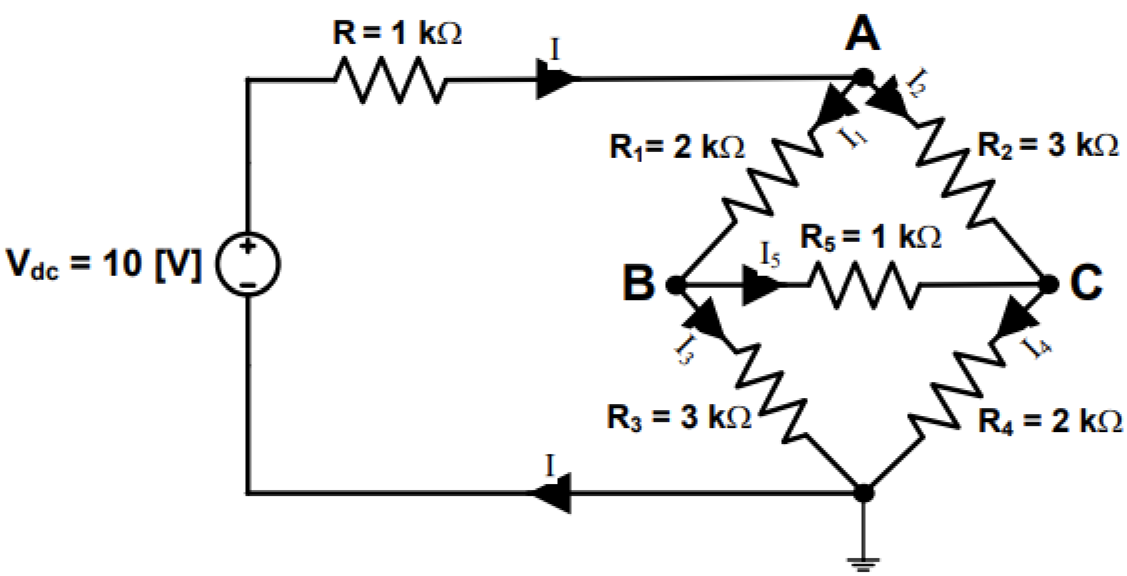
R_{eq4} = (1/3.3k + 1/2.9k)^-1= 1.54k

$R_{eqfinal}$ = 1.54k + 1k = 2.54k

Discussion of Results:

The voltages obtained from the node equations closely matched those calculated through branch equations. This consistency validates the accuracy of the node equation method in predicting voltages within the circuit. By treating each node as an independent entity and formulating equations based on current conservation principles, we were able to systematically determine the voltages across the entire circuit. I am confident that the insights gained from this experiment will enhance my understanding of circuit analysis principles and aid in tackling more intricate circuit designs in the future.

Post Lab:



$$A = \begin{bmatrix} 11 & -3 & -2 \\ -3 & 11 & -6 \\ -2 & -6 & 11 \end{bmatrix}$$

V_a= 7.083 V

V_b= 3.75 V

V_c=3.33 V

Branch Current:

Branch 1: $(V_{dc}-V_a)/2k = 7.083-3.75/2k = 1.6$ mA $= I_1$

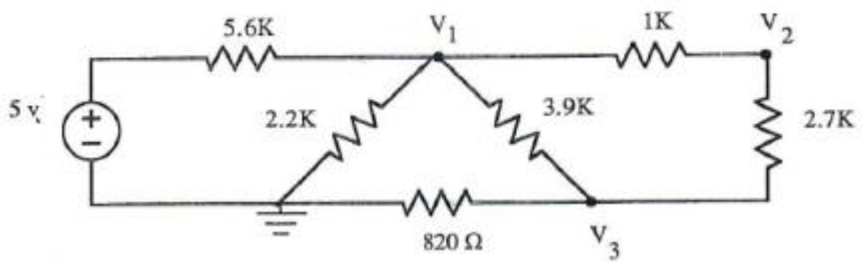
Branch 2: $(V_a-V_c)/3k = 7.083-3.33/3k = 1.25$ mA $= I_2$

Branch 3: $V_b/3k = 3.75/3k = 1.25$ mA $= I_3$

Branch 4: $V_c/2k = 3.33/2k = 1.67$ mA $= I_4$

Branch 5: $(V_b-V_c)/1k = 3.75-3.33= 0.42$ mA $= I_5$

2.



Node Equations:

$(V_1-V_2)/1k + (V_1-5V)/5.6k + V_1/2.2k + (V_1-V_3)/3.9k = 0$

$(V_2-V_1)/1k + (V_2-V_3)/2.7k = 0$

$(V_3-V_1)/2.9k + (V_3-V_2)/2.7k + V_3/0.82 = 0$

$$A = \begin{bmatrix} 90788 & -48048 & -12320 \\ -27 & 37 & -10 \\ -2214 & -3198 & 15942 \end{bmatrix}$$

V_1=0.892 V

V_2=0.724 V

V_3=0.27 V