EE100 Fall 2008
Guest Lecture 1: Nodal Analysis

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Three announcements…

1. Please DO NOT individually email the TAs (or me) conceptual questions about the homework, lecture, lab or exam. USE BSPACE!

2. READ the policies on the course website (especially the General Course Information handout, this is also duplicated on bspace).

3. IF you email me conceptual questions or obvious course policy questions, I WILL NOT RESPOND.

Recap of EE100 so far…

Prof. Chua	Reading (Textbook and Online notes)
1. Circuit variables - voltage, current, power 1. Element Laws - linear resistors etc. 2. KCL and KVL - cutsets 3. Associated reference convention 4. op-amps (MOTIVATION)	1. Textbook: - Chapters 1 through 4 2. Online notes: - Supplementary notes from Prof. Chua's book

Core: Chapter 4 from your book

NODAL ANALYSIS! (Sec. 4.2-4.4)] UNDERSTAND

This week: Nodal and Mesh analysis

UNDERSTAND NODAL ANALYSIS!

Turns out incorrect nodal analysis is the number one "A grade killer" in EE100/EE42!!!!!

"Steps" involved in Nodal Analysis

(1) Identify the number of unknown essential nodes.

↳ (Chapter 4) A node where three or more circuit elements are joined

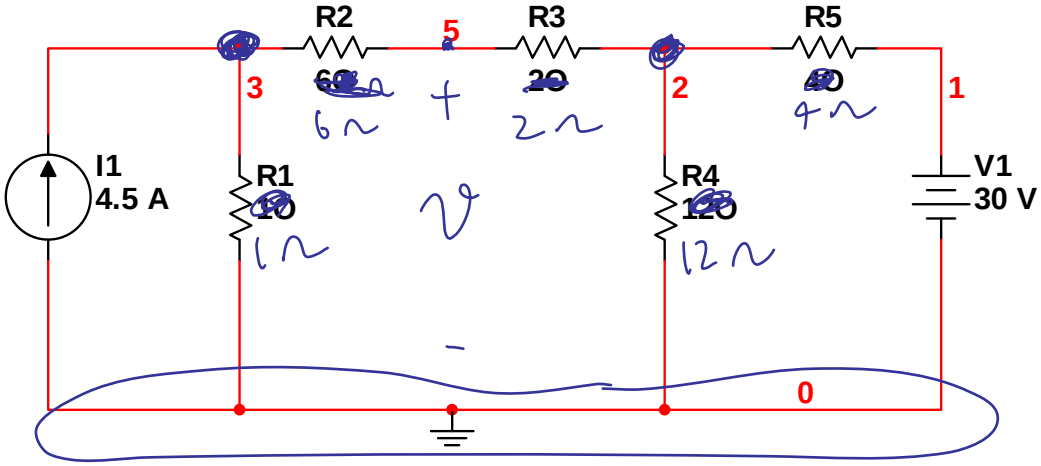
(2) $n_e \triangleq$ number of unknown essential nodes

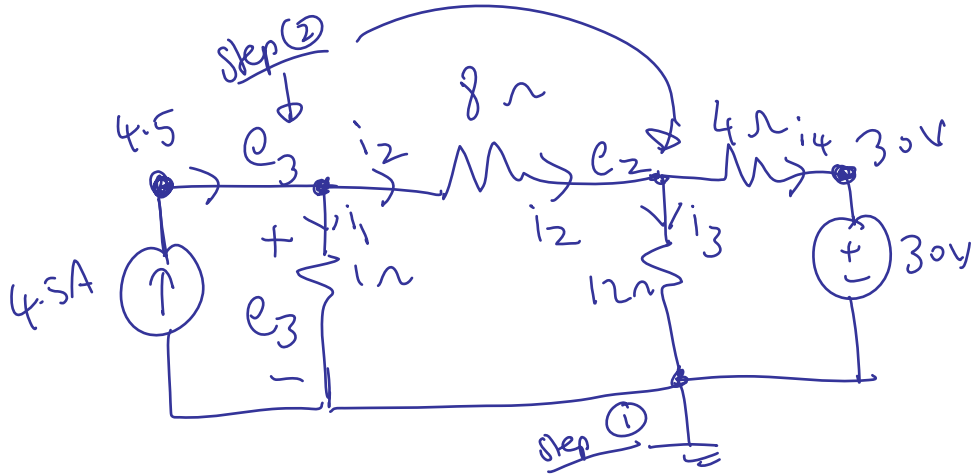
⇒ you need $n_e - 1$ KCL eqns. [one of your essential nodes is reference (0 V)]

(3) Write KCL at each unknown essential node.

(4) Replace unknown currents in KCL by unknown essential node voltages via element laws.

Example: Drill problem 4.2 on p.100. Find v in the circuit below using nodal analysis.

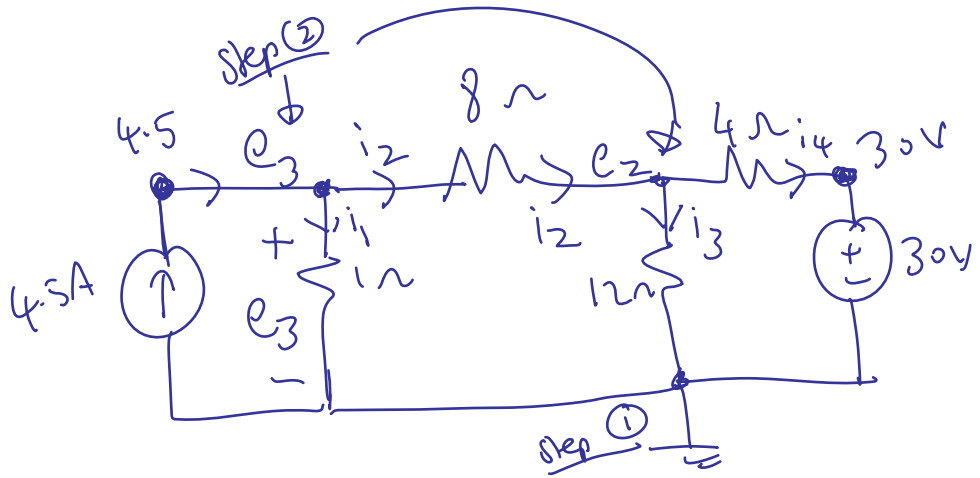




Step ③

KCL: @ e_3: $4.5 = i_1 + i_2$ || @ e_2: $i_2 = i_3 + i_4$

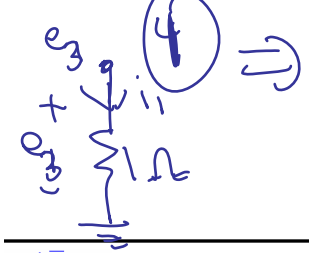
Example: Drill problem 4.2 on p.100. Find v in the circuit below using nodal analysis.



Step ③

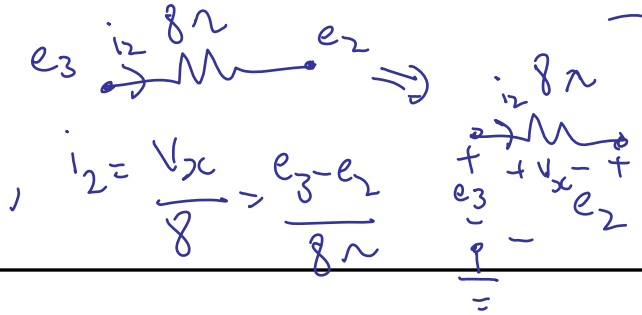
KCL: @ e_3: $4.5 = i_1 + i_2$ (1) || @ e_2: $i_2 = i_3 + i_4$ (2)

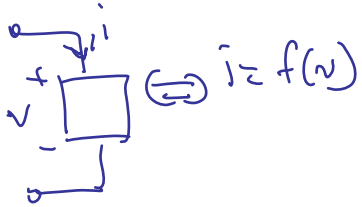
Step ④: Rewrite unknown currents in Step ③ with unknown node voltages [USE ASSOCIATED SIGN CONVENTION]



(1) $\Rightarrow$ $4.5 = i_1 + i_2$

$i_1 = \frac{e_3 - 0}{1} = \frac{e_3}{1\,\Omega}$, $i_2 = \frac{V_x}{8} = \frac{e_3 - e_2}{8\,\Omega}$





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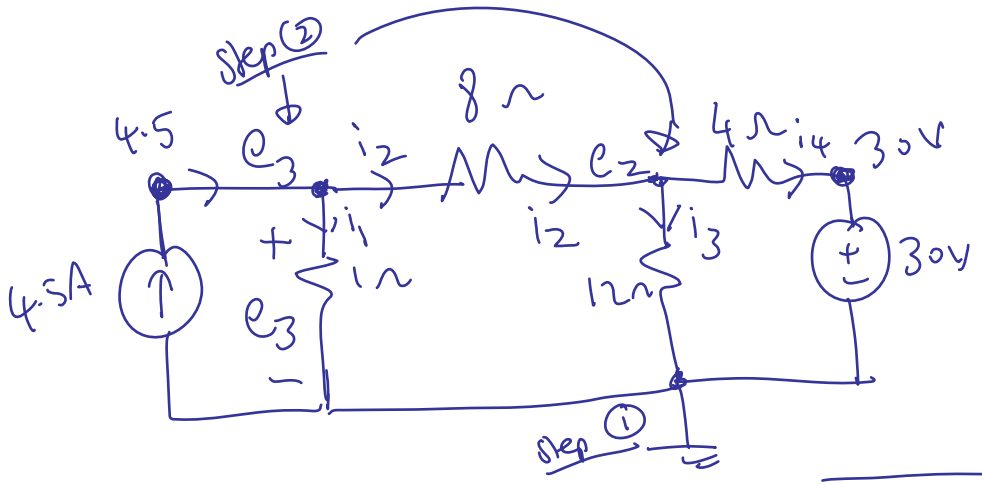
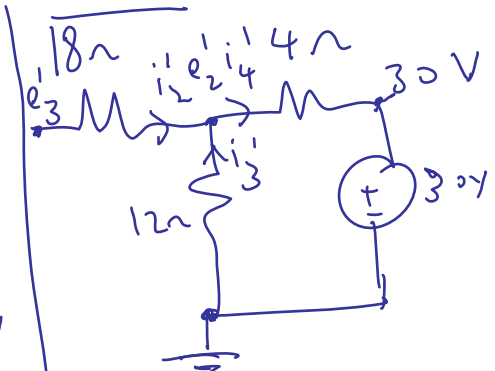




KCL @ e_2': $i_2' + i_3' = i_4'$

$\Rightarrow \frac{e_3' - e_2'}{18} + \frac{0 - e_2'}{12} = \frac{e_2' - 30}{4}$

Step ③

KCL: @ e_3: $4.5 = i_1 + i_2$ (1) || @ e_2: $i_2 = i_3 + i_4$ (2)

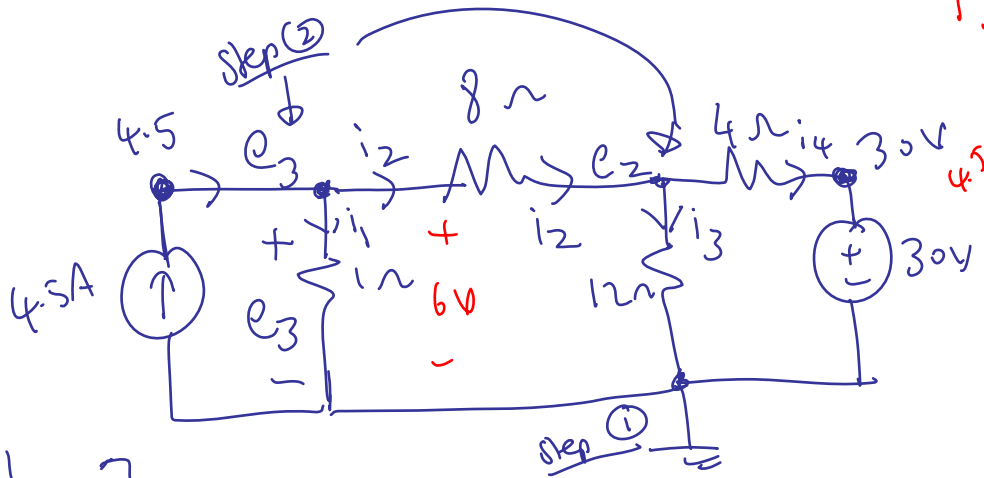
Step ④

@ e_3: $4.5 = \frac{e_3}{1\,\Omega} + \frac{e_3 - e_2}{8\,\Omega}$ (3) || @ e_2: $\frac{e_3 - e_2}{8} = \frac{e_2}{12} + \frac{e_2 - 30}{4}$ (4)

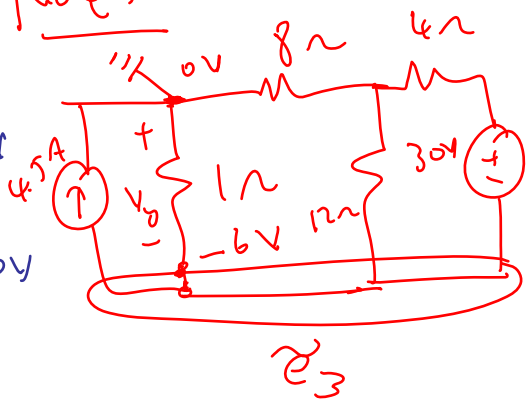
From eqns. ③ & ④ $\Rightarrow$ ③ $\Rightarrow (4.5)8 = 8e_3 + e_3 - e_2 \Rightarrow 9e_3 - e_2 = 36$

④ $\Rightarrow 3(e_3 - e_2) = 2e_2 + 6e_2 - 180 \Rightarrow 3e_3 - 11e_2 = -180$

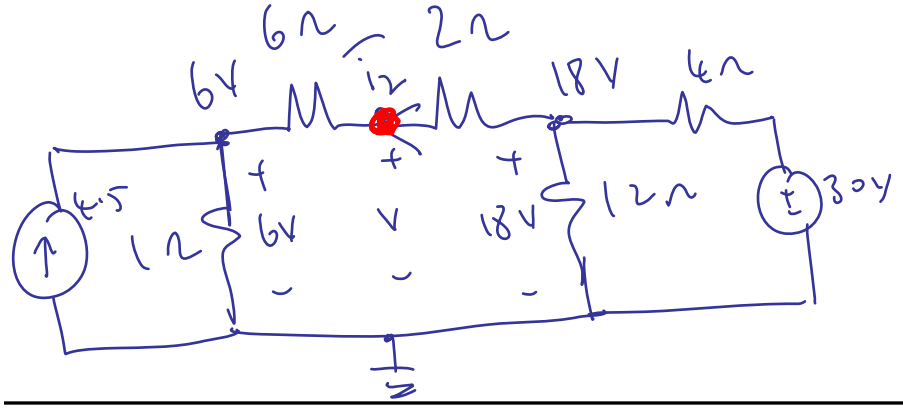
Example: Drill problem 4.2 on p.100. Find v in the circuit below using nodal analysis.



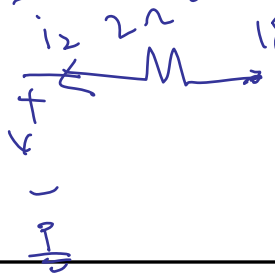
Note:



$$\left.\begin{aligned} 9e_3 - e_2 &= 36 \\ 3e_3 - 11e_2 &= -180 \end{aligned}\right] \Rightarrow \begin{bmatrix} 9 & -1 \\ 3 & -11 \end{bmatrix} \begin{bmatrix} e_3 \\ e_2 \end{bmatrix} = \begin{bmatrix} 36 \\ -180 \end{bmatrix} \Rightarrow \begin{aligned} e_3 &= 6\ V \\ e_2 &= 18\ V \end{aligned}$$



$$i_2 = \frac{12}{8}\ A \qquad \left[\text{Note: } i_2 = -\bar{i}_2\right]$$



$$\left.\begin{aligned} \bar{i}_2 &= \frac{18 - V}{2} \\ \Rightarrow \quad V &= 15\ V \end{aligned}\right]$$