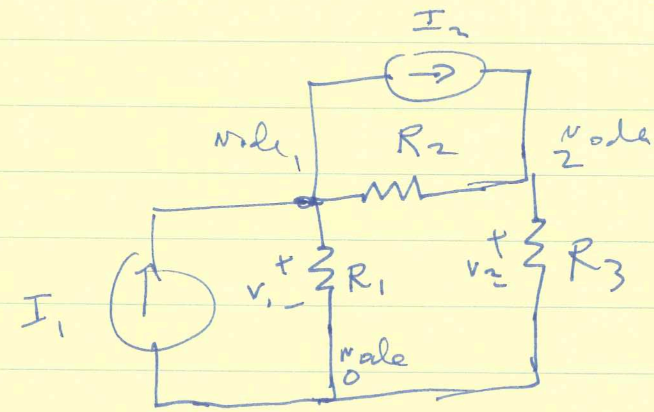
Revs. absolute. Power supply

Nodal/Mesh analysis

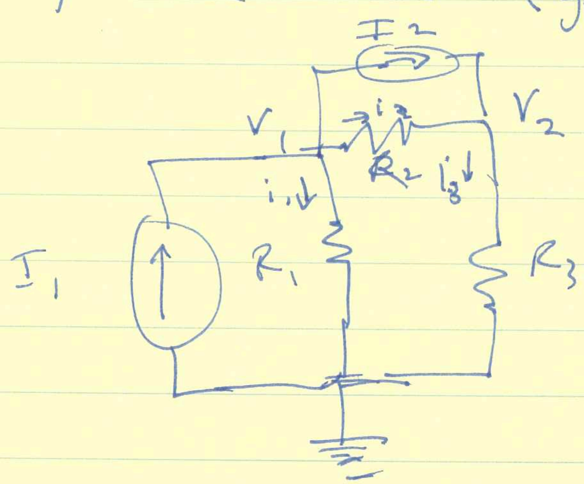
Nodal

1) Select ref node
2) KCL + ohm
3) Solve V_ns.

E.g.



STEP 1 Define reference node (ground)



Node 0 : Reference

STEP 2 Apply KCL, And Ohm's Laws

$\cancel{I_1 + I_2}$ $I_1 = I_2 + i_1 + i_2$

$I_2 + i_2 = i_3$

$$i_1 = \frac{V_1 - 0}{R_1}$$

$$i_2 = \frac{V_1 - V_2}{R_2}$$

$$i_3 = \frac{V_2 - 0}{R_3}$$

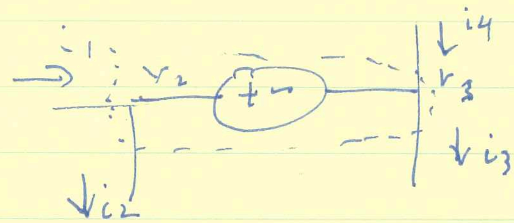
5 Unknowns $i_1\ i_2\ i_3$ $V_1\ V_2$

5 eqns.

$$
\begin{array}{llllll}
(-1)\, i_1 & (-1)\, i_2 & +0\ i_3 & +0\ v_1 & +0\ v_2 & = I_2 - I_1 \\
(1)\ \text{"} & +(0)\ \text{"} & +(0)\ \text{"} & +(0)\ \text{"} & +(0)\ \text{"} & = V_1/R_1 \\
(0)\ \text{"} & (-1)\ \text{"} & (1)\ \text{"} & (0)\ \text{"} & (0)\ \text{"} & = I_2 \\
(\ )\ \text{"} & (1)\ \text{"} & (\ )\ \text{"} & \left(-\frac{1}{R_2}\right)\text{"} & \left(+\frac{1}{R_2}\right)\text{"} & = 0 \\
(0)\ \text{"} & (0)\ \text{"} & (1)\ \text{"} & (0)\ \text{"} & \left(-\frac{1}{R_3}\right)\text{"} & = 0
\end{array}
$$

<u>step 3</u> Solve for all 5.

If voltage source is present:



When we apply KCL, use "supernode" concept:

$$i_1 + i_4 = i_2 + i_3$$

Also need to apply KVL with a loop containing voltage source.

$\Rightarrow$ n equations, n unknowns.

Simplify

$$I_1 = I_2 + i_1 + i_2$$

$$I_2 + i_2 = i_3$$

Express is in terms of V's:

$$I_1 = I_2 + \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_2}$$

$$I_2 + \frac{V_1 - V_2}{R_2} = \frac{V_2}{R_3}$$

Now only 2 unknowns (# of nodes) V_1 V_2

2 eqns.

Called "Nodal analysis"
Allows us to find V's everywhere.

"Nodal analysis applies KCL to find unknown voltages in a given circuit."

"Mesh analysis applies KVL to find unknown currents."

Chapter 3, Problem 2.

For the circuit in Fig. 3.51, obtain v_1 and v_2.

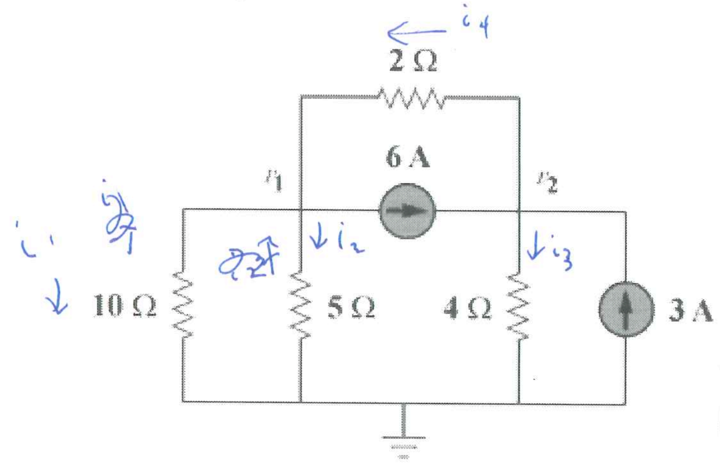


Figure 3.51

Solve voltages @ , currents everywhere

Unknowns

$i_1 \quad i_2 \quad i_3 \quad V_1 \quad V_2$

ohm reduces to:

$V_1 \quad V_2$ unknowns

KCL used to solve

1) Ref

2) KCL + Ohm

$$i_1 = \frac{V_1}{10}$$

$$i_2 = \frac{V_1}{5}$$

$$i_3 = \frac{V_2}{4}$$

$$i_4 = \frac{V_2 - V_1}{2}$$

ohm

KCL

$$+i_1 + i_2 + 6 = i_4 \quad \Rightarrow \quad ① \quad +\frac{V_1}{10} + \frac{V_1}{5} + 6 = \frac{V_2 - V_1}{2}$$

$$\cancel{-i_4 + 6 - i_3 + 3 = 0}$$

$$i_3 + i_4 = 6 + 3$$

$$\cancel{-\frac{V_2 - V_1}{4}} \qquad ② \quad \frac{V_2}{4} + \frac{V_2 - V_1}{4} = 9$$

① ② 2 eqns,

2 unknowns

V_1, V_2 solve.

Kramer???

Chapter 3, Problem 15.

Apply nodal analysis to find $\boldsymbol{i_o}$ and the power dissipated in each resistor in the circuit of Fig. 3.64.

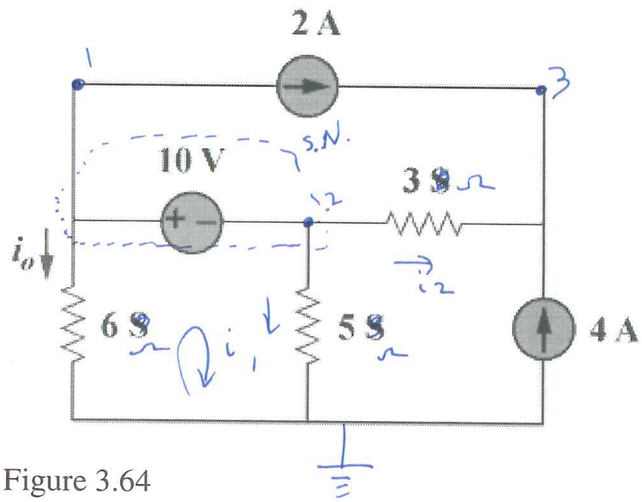


Figure 3.64

1) Ref
2) Ohm
KCL

6 Unknowns

$i_o \quad i_1 \quad i_2$

$V_1 \quad V_2 \quad V_3$

$$\left.\begin{aligned} V_1 &= i_o \cdot 6 \\ V_2 &= i_1 \cdot 5 \\ V_2 - V_3 &= i_2 \cdot 3 \end{aligned}\right\} \text{ohm} \rightarrow$$

reduce to 3 unknowns $i_o \; i_1 \; i_2$

SN KCL IN = OUT

(1) $0 = i_o + 2 + i_2 + i_1$

Node 3 KCL IN = OUT

$\cancel{2 + i_2 = 4}$ (2) $2 + i_2 + 4 = 0$

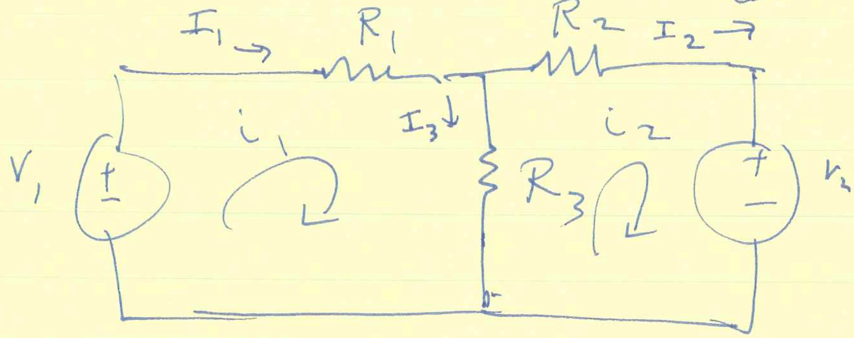
Need KVL w/ loop containing voltage source

(3) $-i_o \cdot 6 + 10 + i_1 \cdot 5 = 0$

3 eqn. 3 unknowns

(1)(2)(3) $i_o \; i_1 \; i_2$ Solve, eq w/ Cramer's rule

Mesh: Closed loop that does not contain any other loops within it.



1

Mesh anal

1) Assign mesh currents $i_1, i_2 \ldots i_n$
2) Apply KVL
3) Solve n eqns. for $i_1 \ldots i_n$

$$-V_1 + R_1 i_1 + R_3(i_1 - i_2) = 0$$

$$R_2 i_2 + V_2 + R_3(i_2 - i_1) = 0$$

2 eqns. 2 unknowns i_1 i_2

Solve.

Nodal Anal vs Mesh Anal:
Depends on particular problem.

Chapter 3, Problem 73.

Write the mesh-current equations for the circuit in Fig. 3.117.

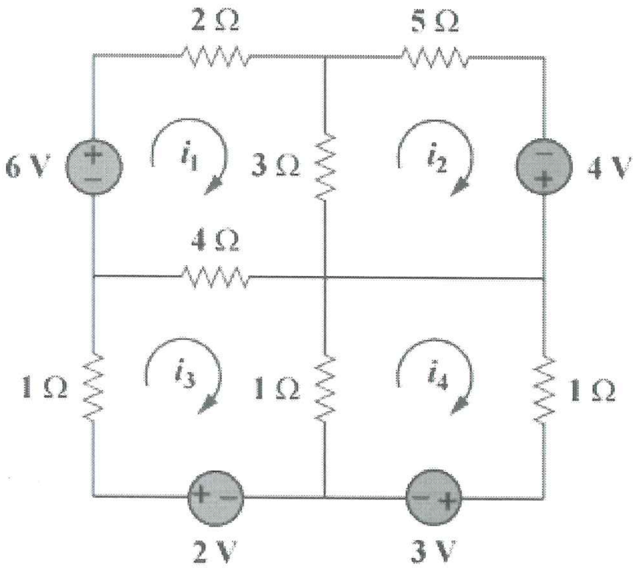


Figure 3.117

1) Assign mesh currents $i_1\ i_2\ i_3\ i_4$

2) KVL

~~$-6V + 2i_1 + 3i_1 +$~~

① $-6 + 2i_1 + (i_1 - i_2)3 + (i_1 - i_3)4 = 0$

② $(i_2 - i_1)3 + i_2 5 - 4 = 0$

③ $i_3 \cdot 1 + (i_3 - i_1)4 + (i_3 - i_4)1 - 2 = 0$

④ $(i_4 - i_3) \cdot 1 + i_4 \cdot 1 + 3 = 0$

④ eqn ④ unknowns. solve.

If mesh has current source, "supermesh", discussed in text. lecture, time permitting.

Chapter 3, Problem 44.

Use mesh analysis to obtain i_o in the circuit of Fig. 3.90.

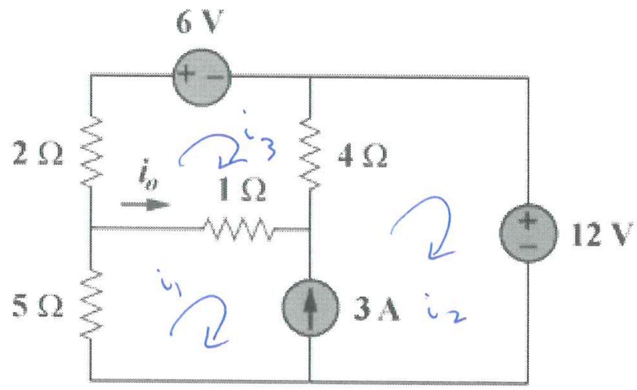


Figure 3.90

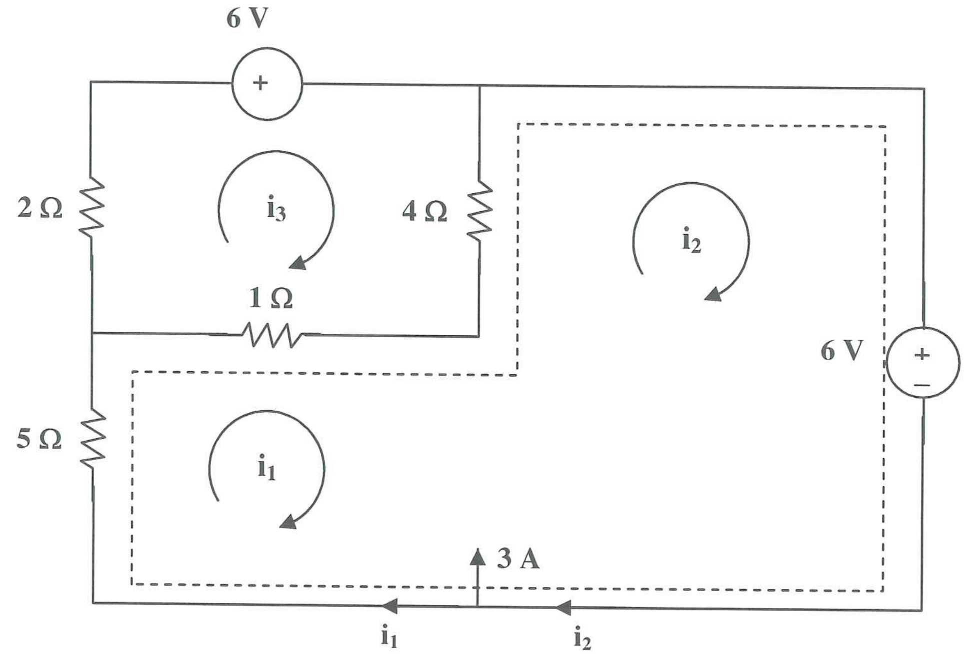
Supermesh: 1) Assign mesh currents

2) Remove current source.

3) Apply KVL for enlarged ~~circle~~ ~~loo~~ loop

4) Solve $i_1 \cdots i_n$

Chapter 3, Solution 44.



Loop 1 and 2 form a supermesh. For the supermesh,

$5i_1 + (i_1 - i_3)\cdot 1 + \cancel{(i_2 - i_3)} + (i_2 - i_3)4 + 6 = 0$

$\cancel{6i_1 + 4i_2 - 5i_3 + 12 = 0}$ (1)

For loop 3, $\cancel{-i_1 - 4i_2 + 7i_3 + 6 = 0}$ (2)

$i_3 \cdot 2 + 6 + (i_3 - i_2)4 + (i_3 - i_1)1 = 0$

Also, $i_2 = 3 + i_1$ (3)

Sol~~ving (1) to (3), $i_1 = -3.067$, $i_3 = -1.3333$; $i_o = i_1 - i_3 =$ **-1.7333 A**~~

3 eqn 1 2 3

3 unknowns i_1 i_2 i_3 solve ✓