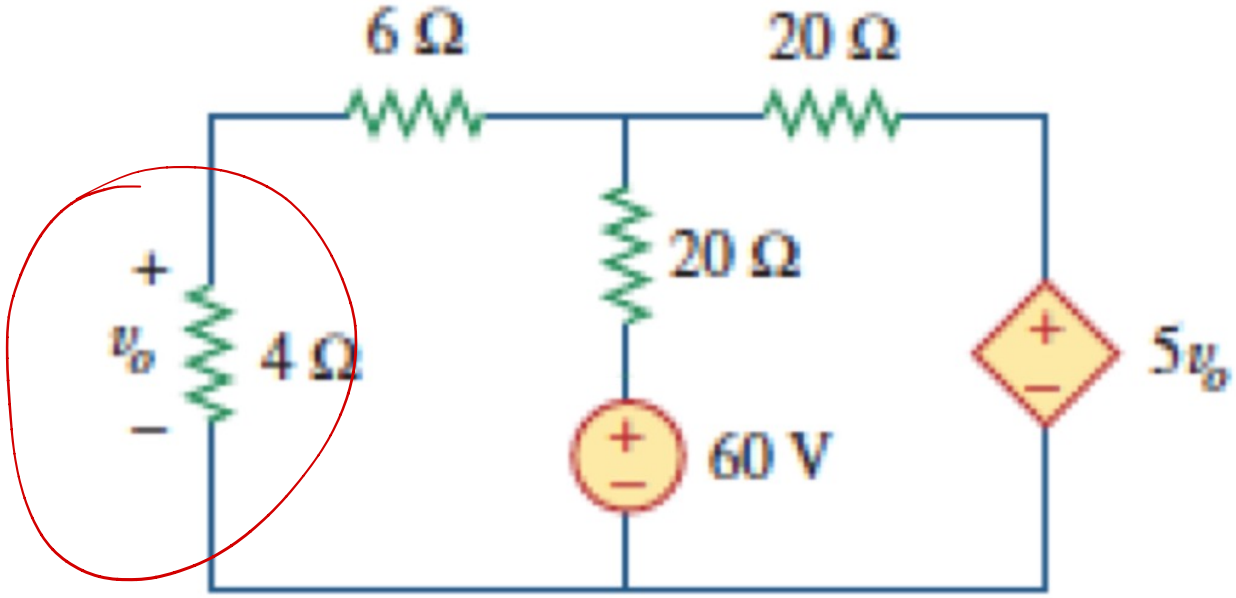
Lecture 11
Node Analysis – 4 of 7

dependent sources

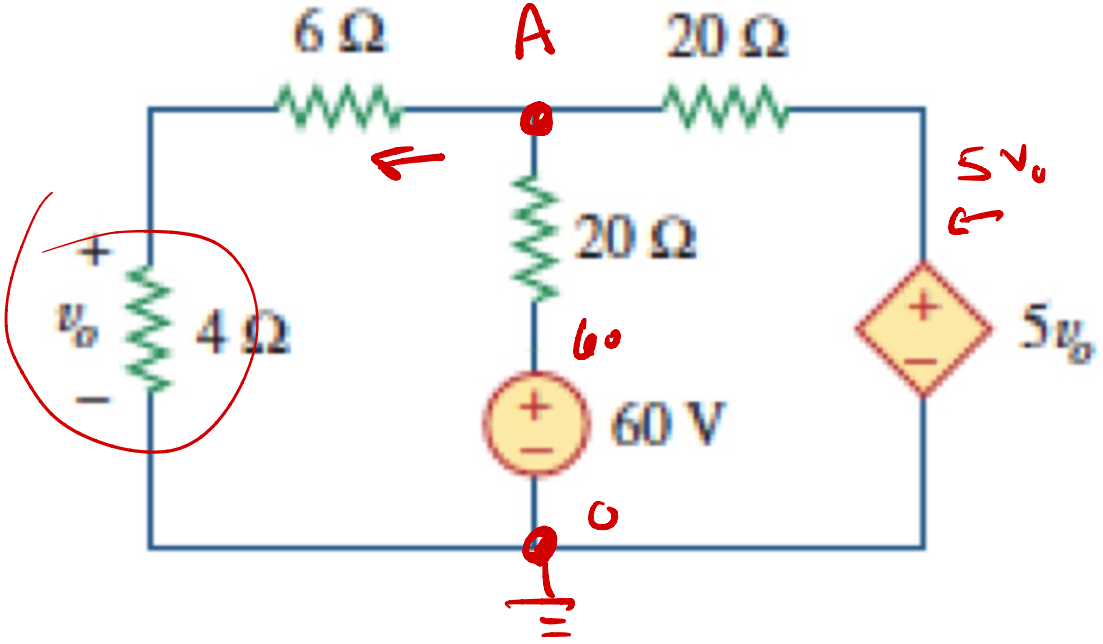
Extension #3 – dependent sources

- Consider:



  - Write node equations as usual,
  - Add an equation "defining" the controlling variable in terms of the node voltages

Example (solved on next slide)



1- label nodes + ground

2- KCL at A

$$\frac{A}{10} + \frac{A-60}{20} + \frac{A-5v_o}{20} = 0$$

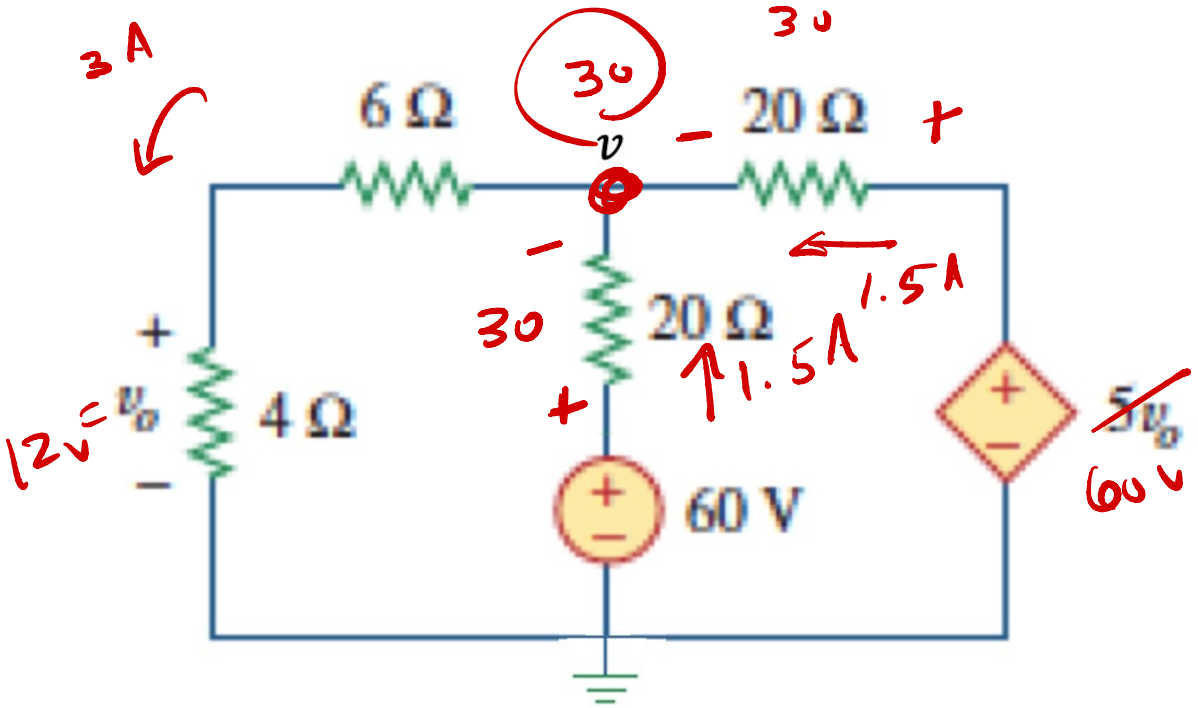
3- write voltage div. eq

$$v_o = A \cdot \frac{4}{10}$$

4 solve - substitut

$$\frac{A}{10} + \frac{A-60}{20} + \frac{A-2A}{20} = 0$$

$$A\left(\frac{1}{10} + \frac{1}{20} - \frac{1}{20}\right) = \frac{60}{20}$$



Node equation:

$$\frac{v}{10} + \frac{v - 60}{20} + \frac{v_1 - 5v_0}{20} = 0$$

Relate v_0 to the node:

$$v_0 = \frac{4}{10} v$$

$$4v - 5v_0 = 60$$

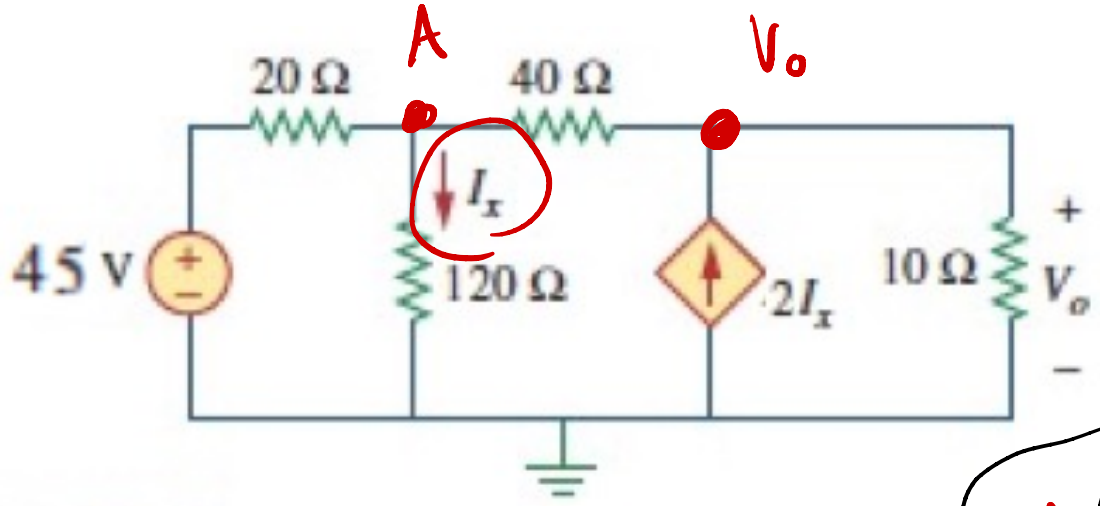
$$4v - 5\frac{4}{10}v = 60$$

$$v = 30\ volts$$

1 - label

$V_o = 10\ V$

Example: find V_0



2 - KCL

A:

$$\frac{A-45}{20} + \frac{A}{120} + \frac{A-V_o}{40} = 0$$

V_o:

$$\frac{V_o - A}{40} + \frac{V_o}{10} - 2I_x = 0$$

$-\frac{A}{40}$

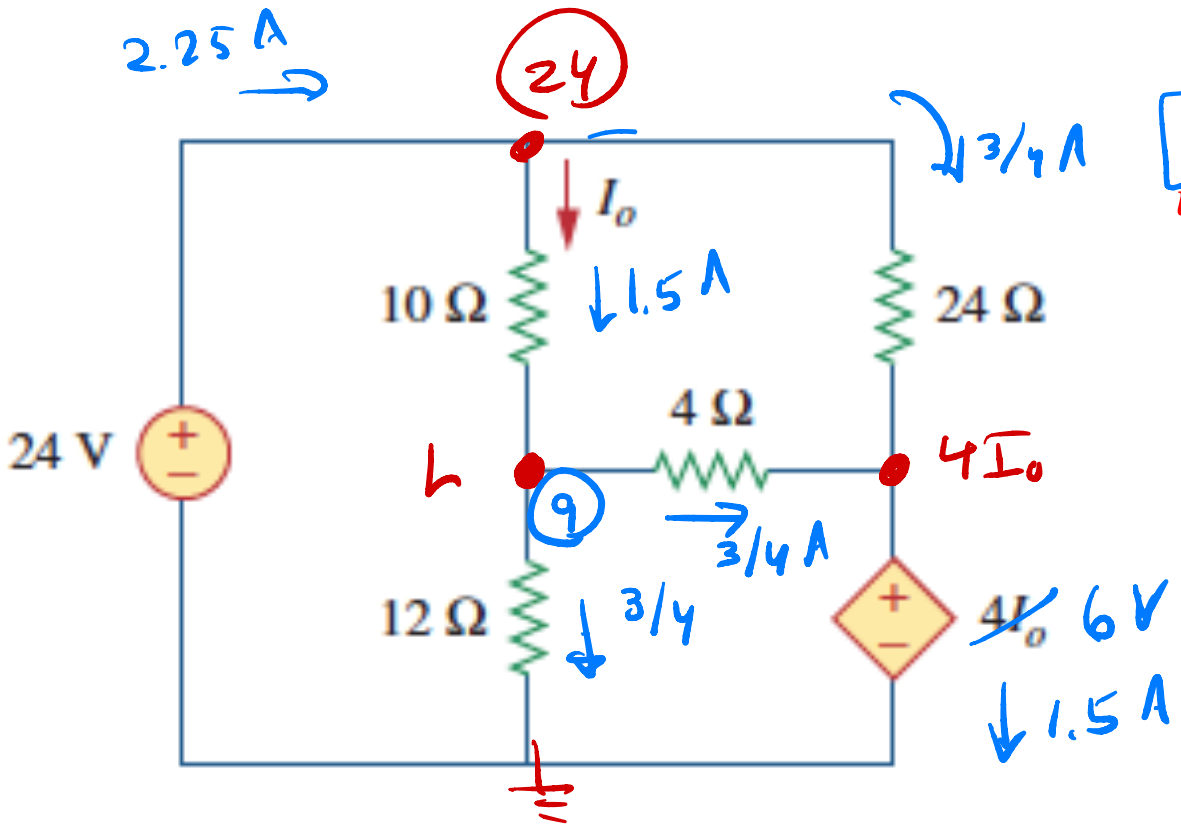
3 - define i_x - dimension

$$i_x = \frac{A}{120}$$

$$A\left(\frac{1}{20} + \frac{1}{120} + \frac{1}{40}\right) - V_o\left(\frac{1}{40}\right) = \frac{45}{20}$$

$$-A\left(\frac{1}{40} + \frac{1}{60}\right) + V_o\left(\frac{1}{40} + \frac{1}{10}\right) = 0$$

Example:



$v_L = 9\ V,$
$i_0 = 1.5\ A$
$v_R = 6\ V$

1- label

2- write KCL @ L

$$\frac{L}{12} + \frac{L-24}{10} + \frac{L-4I_o}{4} = 0$$

L = 9 volts

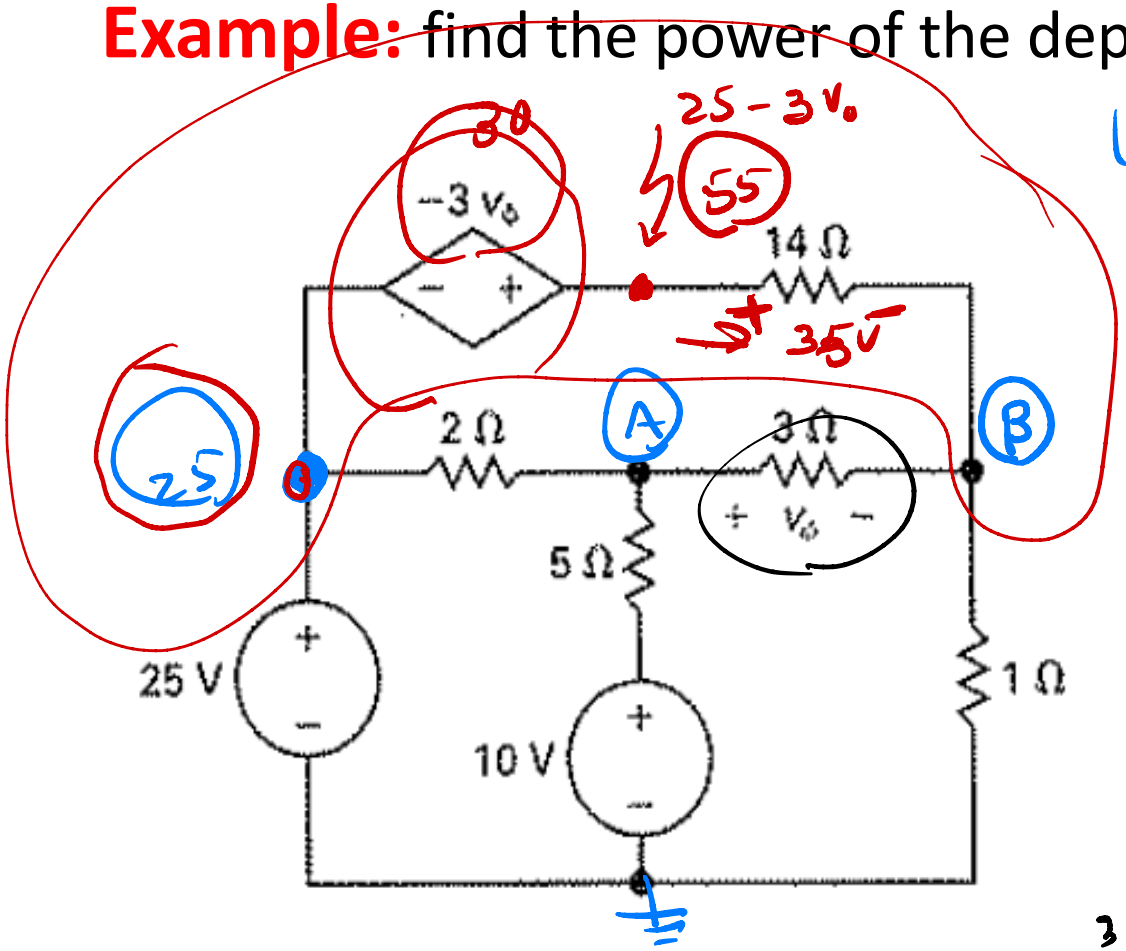
3- extra eq. Ohm's Law

$$I_o = \frac{24-L}{10}$$

$$4I_o = \frac{48-2L}{5}$$

P = – 36 W

Example: find the power of the dependent source



1- label and choose ground

2- node eqs:

$$\frac{A-25}{2} + \frac{A-10}{5} + \frac{A-B}{3} = 0$$

$$\frac{B}{1} + \frac{B-A}{3} + \frac{B-25+3v_0}{14} = 0$$

3- define v_0

$$v_0 = A - B$$

$A = 10 \quad B = 20$

$v_0 = -10$

$v_s = 30\ V$

$i_s = -\frac{35}{14}$

$$P = 30 \cdot \left(-\frac{35}{14}\right)$$

$$30\left[\frac{A-25}{2}+\frac{A-10}{5}+\frac{A-B}{3}=0\right.$$

$$42\left[\frac{B}{1}+\frac{B-A}{3}+\frac{B-25+3(A-B)}{14}=0\right.$$

$$15A-375+6A-60+16A-10B$$

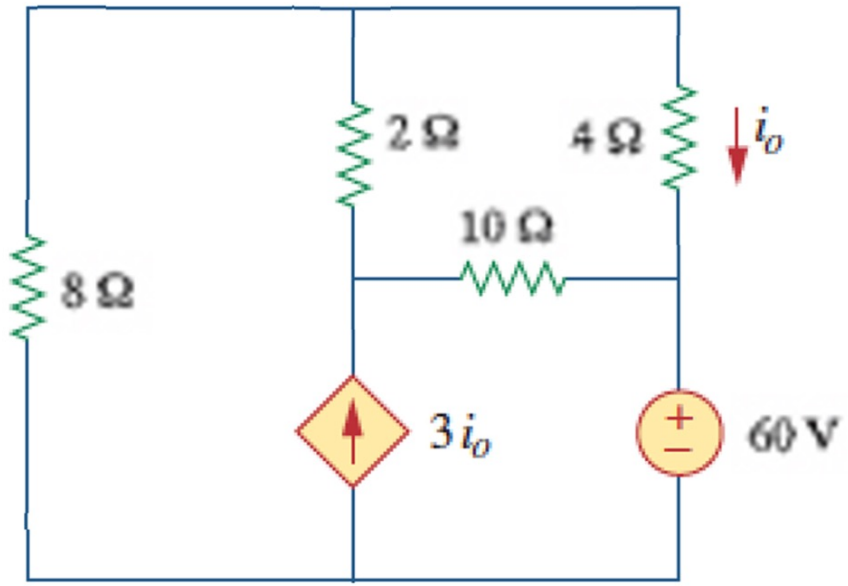
$$42B+14B-14A+3B-75+9A-9B$$

$$31A-10B=435$$

$$-5A+50B=75$$

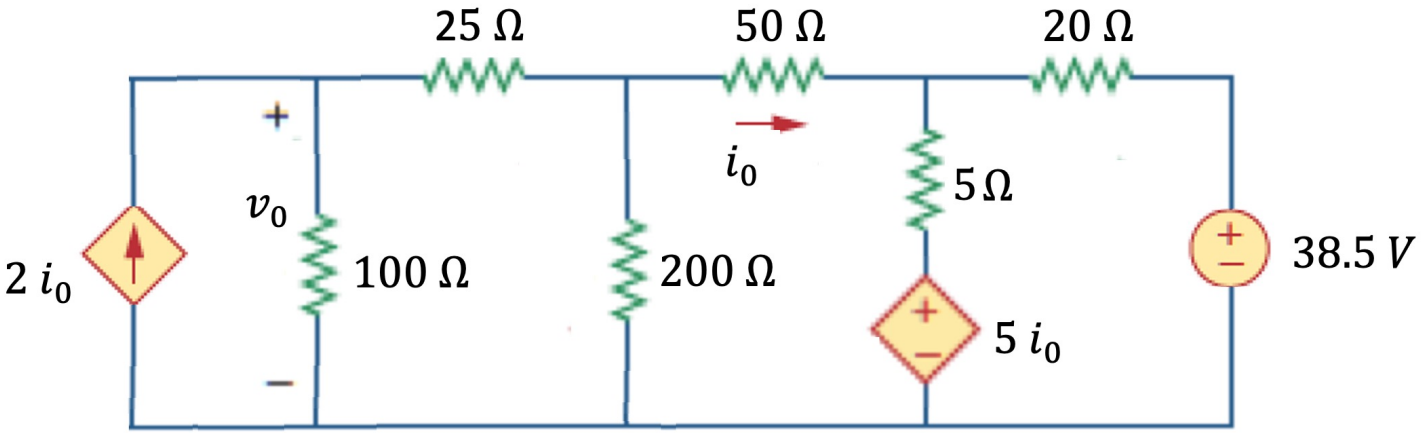
$i_0 = 11.25\ A$

Practice problem: find i_0



$v_o = -50\ V$

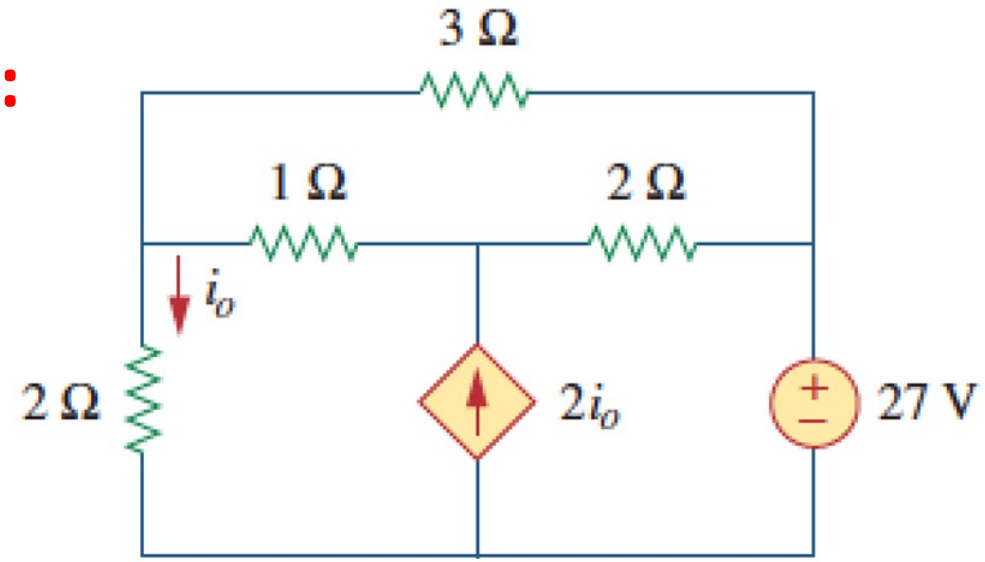
Practice problem: find v_0



$v_L = 36\ V$

$v_R = 57\ V$

Practice Problem:



I_0=7.5 A

Practice problem: find I_0