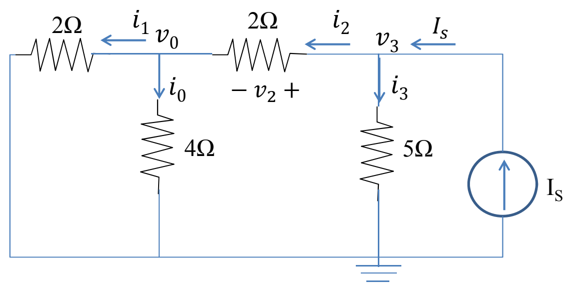
Problem 1 Find I_S so that $i_0 = 1A$. Also find i_0 for $I_S = 15A$. Use Linearity.



Pick the ground and assign node voltages, resistor voltages and currents

Start from $i_0 = 1A$, then by basic laws:

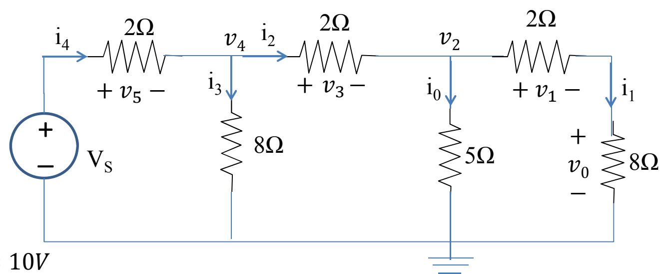
$$v_0 = 4i_0 = 4 \times 1 = 4V$$
$$i_1 = \frac{v_0}{2} = \frac{4}{2} = 2A$$
$$i_2 = i_0 + i_1 = 1 + 2 = 3A$$
$$v_2 = 2i_2 = 2 \times 3 = 6V$$
$$v_3 = v_0 + v_2 = 4 + 6 = 10V$$
$$i_3 = \frac{v_3}{5} = \frac{10}{5} = 2A$$
$$I_s = i_2 + i_3 = 3 + 2 = 5A$$

Thus, $\frac{i_0}{I_s} = \frac{1}{5} \Rightarrow i_0 = \frac{1}{5} I_s$

So when I_s =15A,
$i_0 = \frac{1}{5} I_s = \frac{1}{5} \times 15 = 3A$

Problem 2: Find V_S so that v_0 = 5V, 8V, 3V respectively. What is v_0 when V_S = 26V? Use Linearity.

Start from $v_0 = 8V$, then other variables will be whole numbers. Then,



$$i_1 = v_0/8 = 1A$$
$$v_1 = 2i_1 = 2V$$
$$v_2 = v_0 + v_1 = 2 + 8 = 10V$$
$$i_0 = \frac{v_2}{5} = 10/5 = 2A$$
$$i_2 = i_0 + i_1 = 2 + 1 = 3A$$
$$v_3 = 2i_2 = 2 \times 3 = 6V$$
$$v_4 = v_2 + v_3 = 6 + 10 = 16V$$
$$i_3 = \frac{v_4}{8} = \frac{16}{8} = 2A$$
$$i_4 = i_2 + i_3 = 3 + 2 = 5A$$
$$v_5 = 2i_4 = 2 \times 5 = 10V$$
$$V_s = v_4 + v_5 = 16 + 10 = 26V$$

$v_0 = 8V \longleftrightarrow V_s = 26V$

$k = \frac{v_0}{V_s} = \frac{8}{26} = 0.3077 \Rightarrow$ $v_0 = 0.3077V_s$, $V_s = v_0/0.3077$

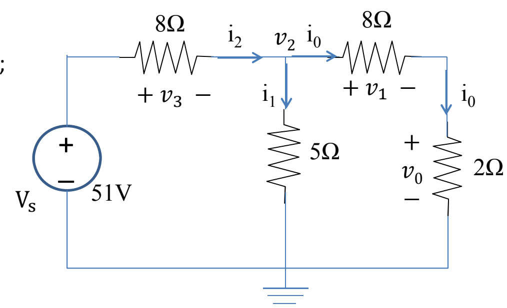
So when $v_0 = 5V$, $V_s = 5/0.3077 = 16.25V$
when $v_0 = 8V$, $V_s = 8/0.3077 = 26V$
when $v_0 = 3V$, $V_s = 3/0.3077 = 9.75V$

When $V_s = 26V, v_0 = 26 \times 0.3077\,V = 8V$

You may start v_0 with a different number, but other variables may not be whole numbers.

Problem 3: Apply Linearity to calculate v_0.

Assign ground and other variables.
Assume v_0 to be a certain number;
Use basic laws to find the corresponding V_s
(ignore the given value 51V)



Start with $v_0 = 2V$:

$v_0 = 2V$

$i_0 = \frac{v_0}{2} = 1A$

$v_1 = 8i_0 = 8V$

$v_2 = v_1 + v_0 = 8 + 2 = 10V$

$i_1 = \frac{v_2}{5} = \frac{10}{5} = 2A$

$i_2 = i_0 + i_1 = 1 + 2 = 3A$

$v_3 = 8i_2 = 8 \times 3 = 24V$

$V_s = v_2 + v_3 = 10 + 24 = 34V$

In summary: $v_0 = 2V \Rightarrow V_s = 34$

Thus $k = \frac{v_0}{V_s} = \frac{2}{34} = \frac{1}{17}$

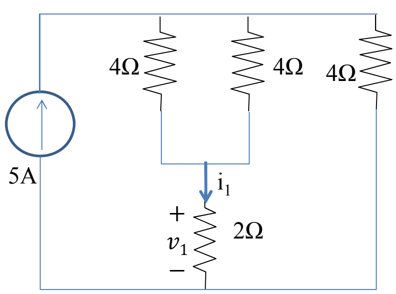
$\Rightarrow v_0 = \frac{1}{17} V_s$

So when $V_s = 51V$,

$v_0 = \frac{1}{17} \times 51 = 3V$

Problem 4: Determine v_0 by superposition.

Due to 5A: turn off 8V with short circuit.

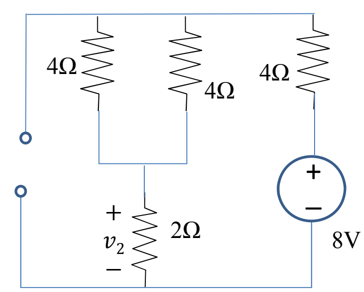


Since 4//4+2Ω is in parallel with 4Ω,
By current division:

$i_1 = \frac{4}{4+4} \times 5 = 2.5V;$

$v_1 = 2i_1 = 5V$

Due to 8V, turn off 5A with open circuit:



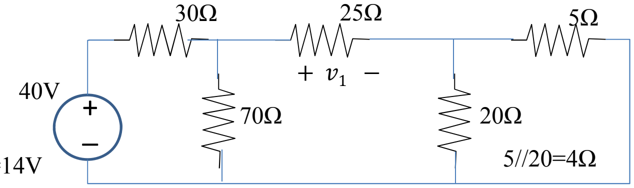
By voltage division,

$v_2 = \frac{2}{2+2+4} \times 8 = 2V$

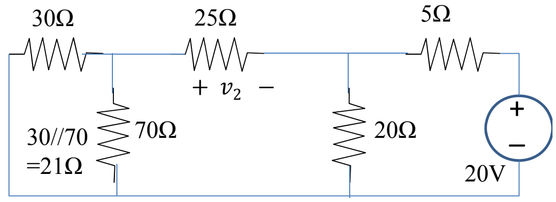
Thus by superposition:

$v_0 = v_1 + v_2 = 5 + 2 = 7V$

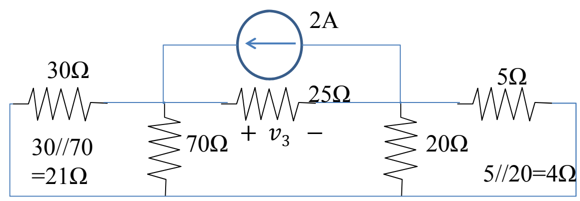
Problem 5



$v_1 = \frac{29||70}{29||70+30} \times 40 \times \frac{25}{25+4}$ V=14V



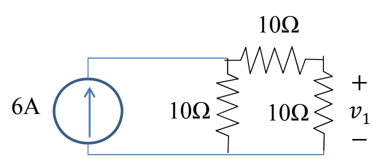
$v_2 = -\frac{46||20}{46||20+5} \times 20 \times \frac{25}{25+21}$ V= -8V



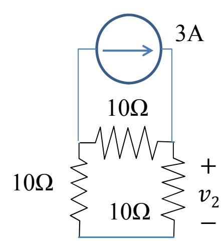
$v_3 = \frac{25}{25+25} \times 2 \times 25$ V= 25V

$v_0 = v_1 + v_2 + v_3$ = 14 – 8 +25 V = 31V

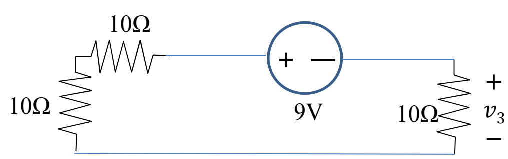
Problem 6



$v_1 = 6 \times \frac{10}{10+20} \times 10$ V = 20V



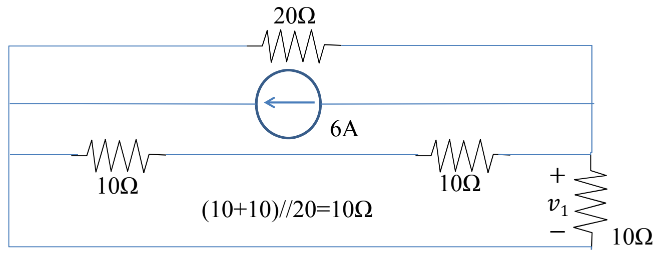
$v_2 = 3 \times \frac{10}{10+20} \times 10$ V = 10V



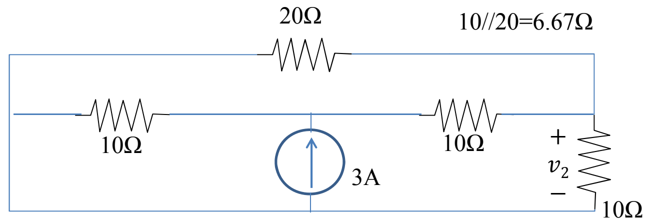
$v_3 = -9 \times \frac{10}{30}$ V = -3V

$v_0 = v_1 + v_2 + v_3$ = 20 + 10 - 3 V = 27V

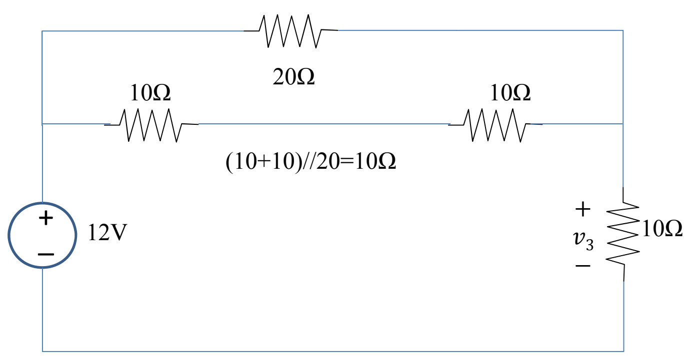
Problem 7



v_1= -6 × $\frac{10}{10+10}$ × 10 = -30V



v_2= 3 × $\frac{10}{6.67+10+10}$ × $\frac{20}{10+20}$ × 10 = 7.5V

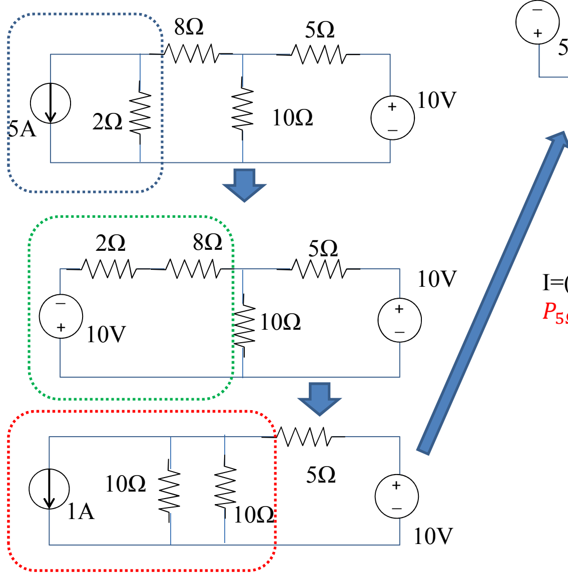


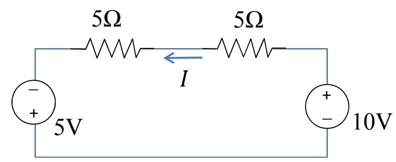
v_3=12 × $\frac{10}{10+10}$ V = 6V

v_0 = v_1 + v_2 + v_3 = -30 + 7.5 + 6 V = -16.5V

Problem 8

Better to keep the 5Ω resistor in every step

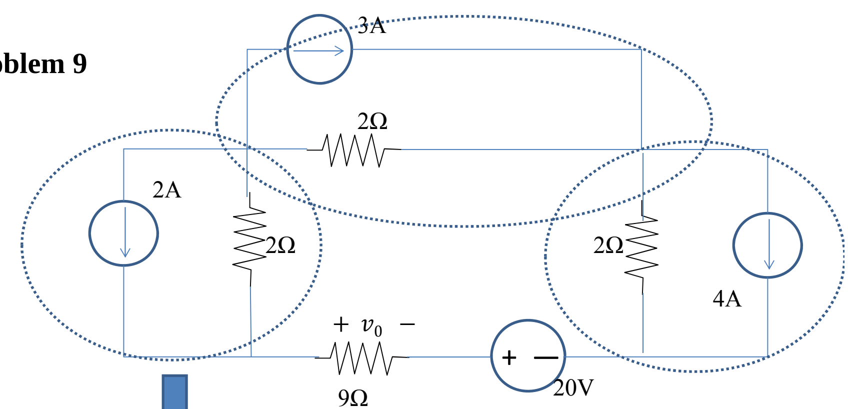


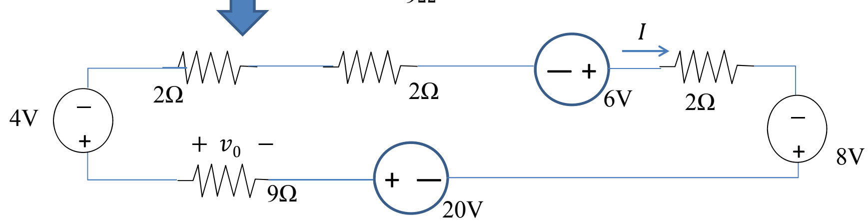


I=(10+5)/(5+5) =1.5A

$P_{5\Omega}$= I^2R=1.5 × 1.5 × 5= 11.25W

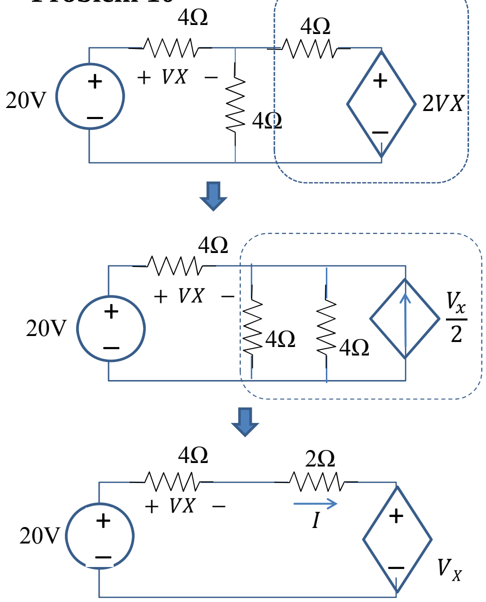
Problem 9





Loop current: $I = \frac{20+8+6-4}{2+2+2+9} = \frac{30}{15} = 2A$; $v_0 = -9I = -9 \times 2 = -18V$

Problem 10



$V_x = 4I;$

KVL: $V_x + 2I + V_x = 20;$

$4I + 2I + 4I = 20;$

$I = 2A;$

$V_x = 4I = 8V$