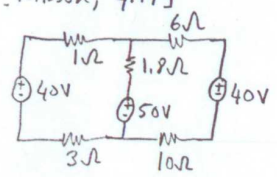
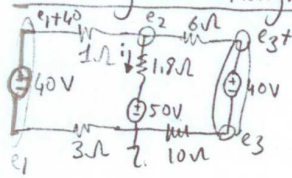
Node - Mesh - Superposition - Source Transformation:

[Nilsson, 4.17]



Find the power delivered by the 50V source.

Solution by Node Analysis:



$$\frac{e_1+40-e_2}{1}+\frac{e_1}{3}=0$$

$$\frac{e_2-(e_1+40)}{1}+\frac{e_2-50}{1.8}+\frac{e_2-(e_3+40)}{6}=0 \Rightarrow \begin{bmatrix} 4 & -3 & 0 \\ -18 & 31 & -3 \\ 0 & -5 & 8 \end{bmatrix}\begin{bmatrix} e_1 \\ e_2 \\ e_3 \end{bmatrix}=\begin{bmatrix} 1340 \\ -120 \\ -200 \end{bmatrix}$$

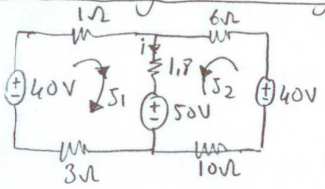
$$\frac{e_3+40-e_2}{6}+\frac{e_3}{10}=0$$

3 eqn's, 3 unknowns

$e_1 = 4.8\,V$; $e_2 = 46.4\,V$; $e_3 = 4\,V$.

$i=\frac{(46.4-50)}{1.8}=-2A$; $P_{50V}=50(-2)=-100$ Watts

Solution by Mesh Analysis:



$$-40+(3+1+1.8)J_1+1.8J_2+50=0 \quad (1)$$

$$-40+1.8J_1+(6+10+1.8)J_2+50=0 \quad (2)$$

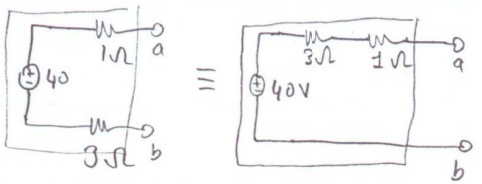
(1)-(2): $4J_1=16J_2 \rightarrow J_1=4J_2$.

From (1): $(5.8)(4J_2)+1.8J_2=-10 \rightarrow J_2=-0.4A$, $J_1=-1.6A$

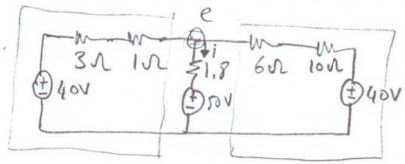
$i=J_1+J_2=-2A \longrightarrow P_{50V}=-100$ Watts

2 eqn's 2 unknowns

Solution by circuit simplification: (Equivalent circuits)



Both circuits have the same (i,v) characteristics. (Thevenin Equivalent or exchanging series branches)



Since we are only interested in "i", we can substitute the rest of branches and their nodes with simpler but equivalent circuits.

Node Equation: $\frac{e-50}{1.8}+\frac{e-40}{4}+\frac{e-40}{16}=0 \rightarrow \frac{5(e-50)}{9}+\frac{5(e-40)}{16}=0$

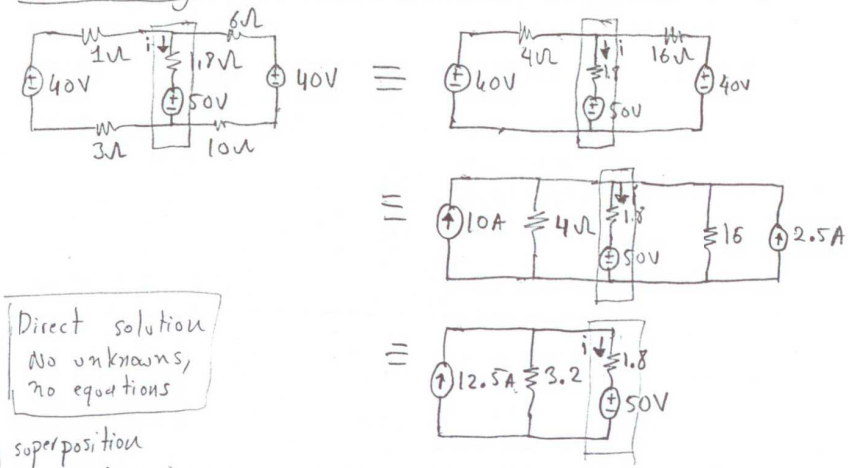
$25e=360+800$

$e=(14+0.4)+32$

$e=46.4\,V \rightarrow$

1 equation, 1 unknown $\rightarrow$ $i=\frac{46.4-50}{1.8}=-2A$; $P_{50V}=-100$ Watts

Solution by Source Transformation and Superposition:



Direct solution, No unknowns, no equations

By superposition

$$i=\underbrace{(12.5)\frac{3.2}{5}}_{\text{current division}}-\underbrace{\frac{50}{5}}_{\frac{50}{R}}=8-10=-2A \quad ; \quad P_{50V}=-100\text{ Watts}$$