Eastern Mediterranean University

"For Your International Career"

Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

INFE221 – Electrical Circuits

Midterm Exam
Spring 2014-15

29 April 2015
Duration: 100 minutes

Instructor: M. K. Uyguroğlu

STUDENT'S	
NUMBER	
NAME	**SOLUTIONS**
SURNAME	
GROUP NO.	

Problem		Points
1		20
2		40
3		20
4		20
TOTAL		100

Problem 1

Find i and R_{eq} if $v_{ab} = 40$ V in the circuit of Fig. P1

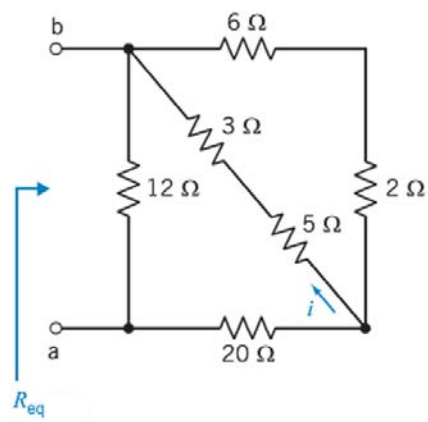


Figure P1

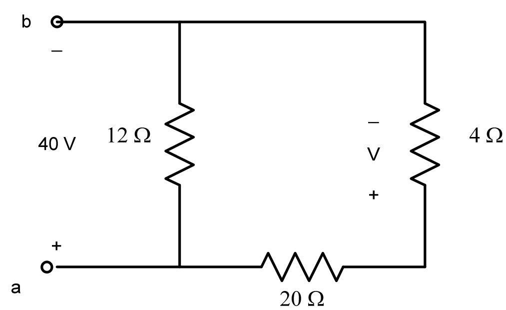
$$\underbrace{R_{eq} = 12//\underbrace{(20+\underbrace{\underbrace{(3+5)}_{8}//\underbrace{(6+2)}_{8}}_{4})}_{24}}_{8} = 8\Omega$$

Using voltage division principle

$$v = 40\frac{4}{24} = \frac{40}{6}\text{V}$$

Therefore

$$i = \frac{v}{8} = \frac{40}{48} = \frac{5}{6} \text{ A}$$



Problem 2

Find v in the circuit of Fig. P2 by using

(a) Nodal Analysis
(b) Mesh Analysis
(c) Superposition
(d) Thevenin's and Norton's theorems.

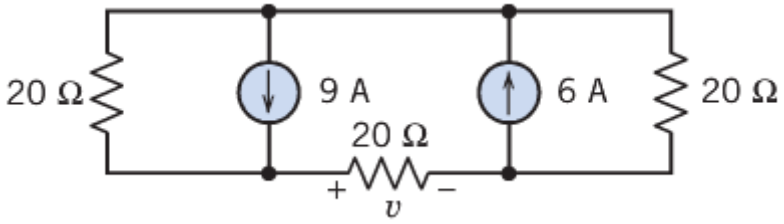
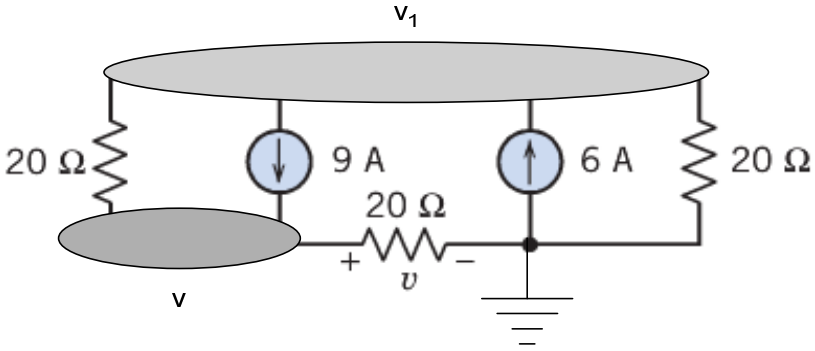


Figure P2

Nodal Analysis



KCL at v:

$$\left(\frac{1}{20}+\frac{1}{20}\right)v-\frac{1}{20}v_1=9$$

multiply both sides by 20 yields:

$$2v-v_1=180.....(1)$$

KCL at v_1:

$$-\frac{1}{20}v+\left(\frac{1}{20}+\frac{1}{20}\right)v_1=6-9=-3$$

multiply bot sides by 20 yields:

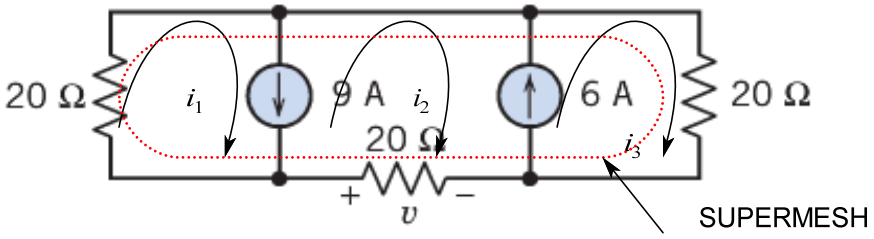
$$-v+2v_1=-60.....(2)$$

Multiplication of Eq.(1) by 2 and addition of Eqs(1) and (2) gives:

$$3v=300$$

$$\boxed{v=100\text{ V}}$$

Mesh Analysis:



KVL around the SUPERMESH

$20i_1 + 20i_2 + 20i_3 = 0$

Where

$i_1 - i_2 = 9 \Rightarrow i_2 = i_1 - 9$

And

$i_3 - i_2 = 6 \Rightarrow i_3 = 6 + i_2 = 6 + i_1 - 9 = i_1 - 3$

Therefore,

$20i_1 + 20(i_1 - 9) + 20(i_1 - 3) = 0$

$60i_1 = 240$

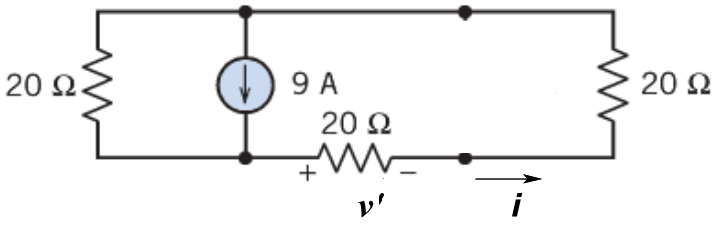
$i_1 = 4 \text{ A}$

$i_2 = -5 \text{ A}$

$i_3 = 1 \text{ A}$

$\boxed{v = -20i_2 = 100 \text{ V}}$

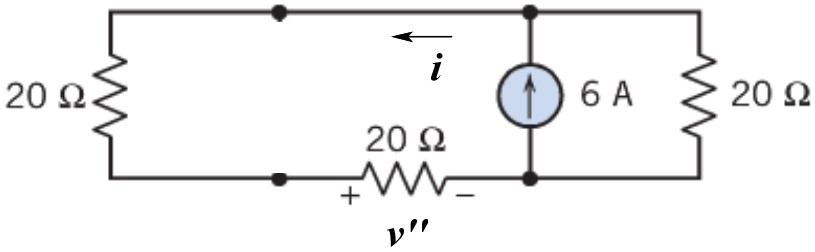
SUPERPOSITION



Using current division principle

$$i = 9\frac{20}{20+40} = 3 \text{ A}$$

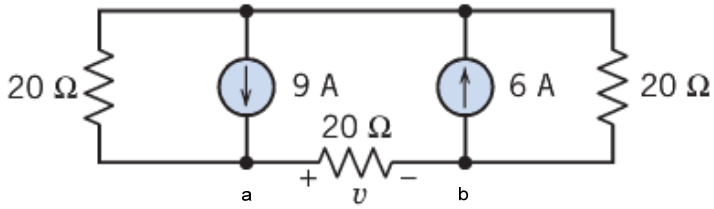
$$v' = 20i = 60 \text{ V}$$



$$v'' = 20i = 20\left(6\frac{20}{60}\right) = 40 \text{ V}$$

$$v = v' + v'' = 60 + 40 = 100 \text{ V}$$

THEVENIN'S and NORTON Theorem



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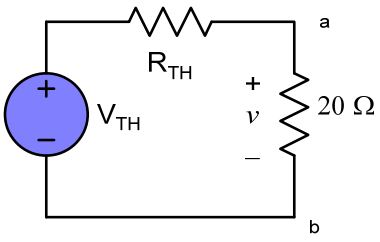
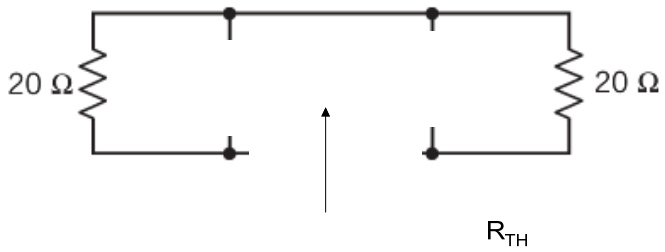
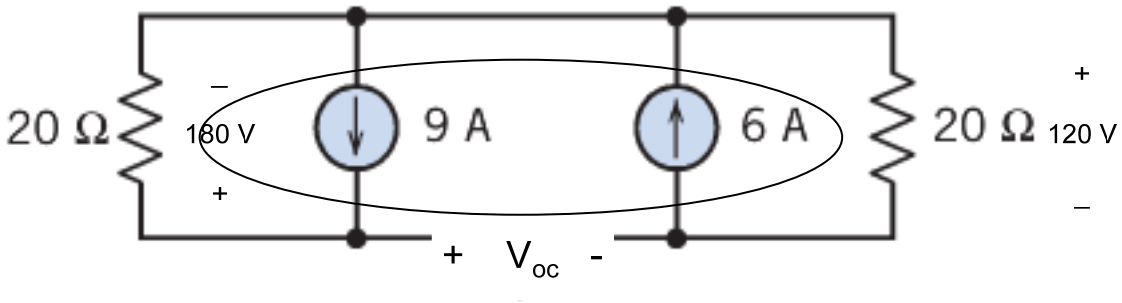


R_{TH}



$R_{TH} = 20 + 20 = 40\Omega$

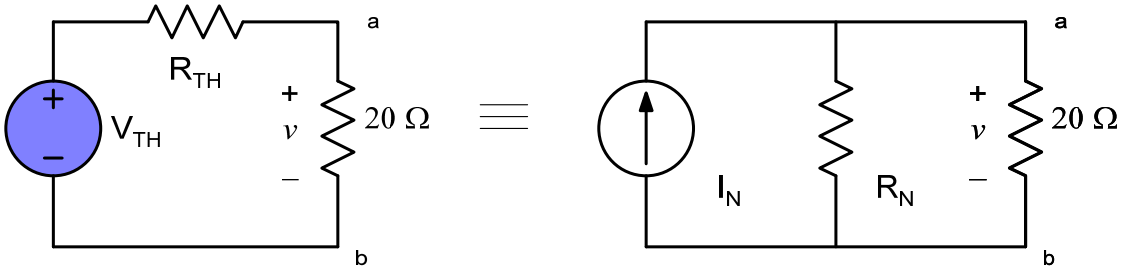


KVL around the outer loop:

$180 + 120 - V_{oc} = 0$

$V_{oc} = 300 \text{ V}$

$$v = V_{TH}\frac{20}{20 + R_{TH}} = 300\frac{20}{60} = 100 \text{ V}$$



$$I_N = \frac{V_{TH}}{R_{TH}} = \frac{300}{40} = 7.5 \text{ A}$$

$R_N = R_{TH} = 40\Omega$

$$v = 20\left(I_N \frac{R_N}{R_N + 20}\right) = 150\frac{40}{60} = 100 \text{ V}$$

Problem 3

Find v in the circuit of Fig.P3.

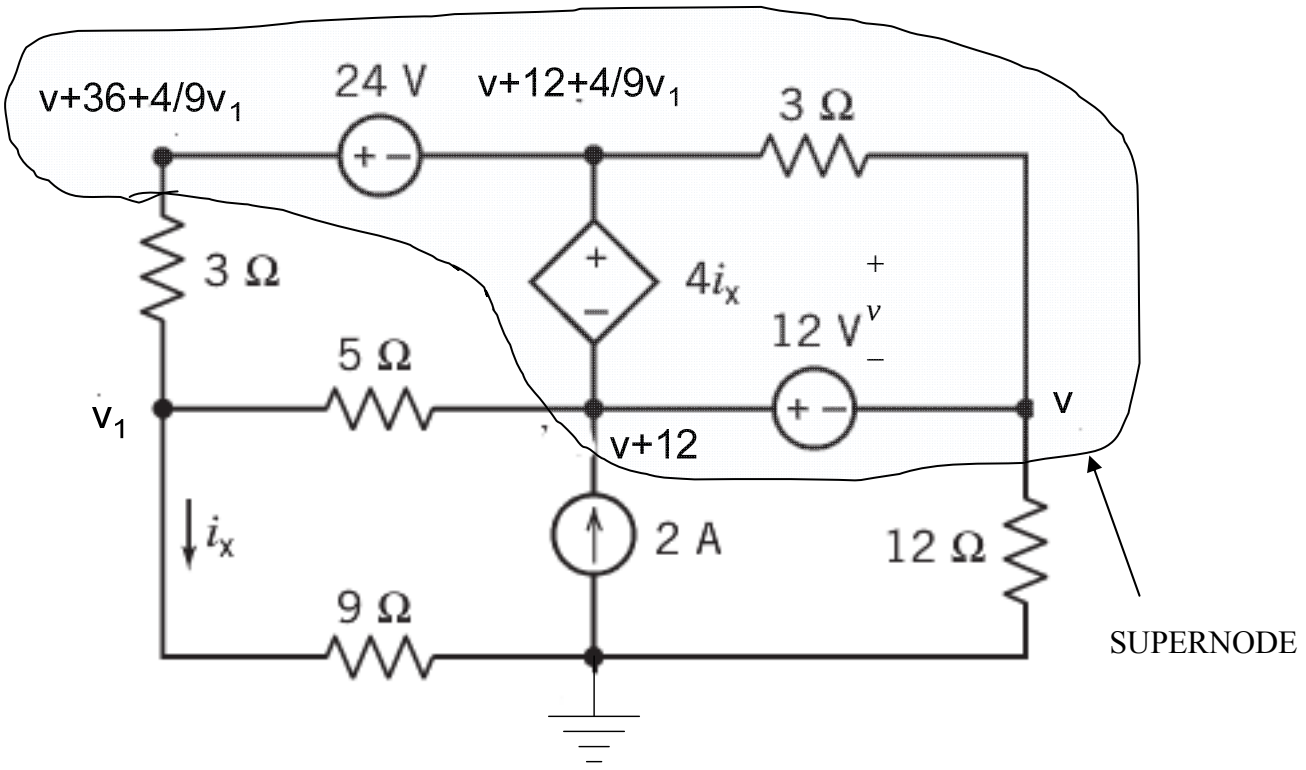


Figure P3

KCL at v_1 ;

$$\left(\frac{1}{3}+\frac{1}{5}+\frac{1}{9}\right)v_1-\frac{1}{3}\left(v+36+\frac{4}{9}v_1\right)-\frac{1}{5}(v+12)=0$$

KCL at SUPERNODE

$$-\left(\frac{1}{3}+\frac{1}{5}\right)v_1+\frac{1}{3}\left(v+36+\frac{4}{9}v_1\right)+\frac{1}{5}(v+12)+\frac{1}{12}v=2$$

$$-\frac{8}{15}v+\frac{67}{135}v_1=\frac{72}{5}$$

$$\frac{37}{60}v-\frac{52}{135}v_1=-\frac{62}{5}$$

$$\boxed{v=-6.037\text{ V}}$$

Problem 4

Find v and i for the circuit of Fig.P4

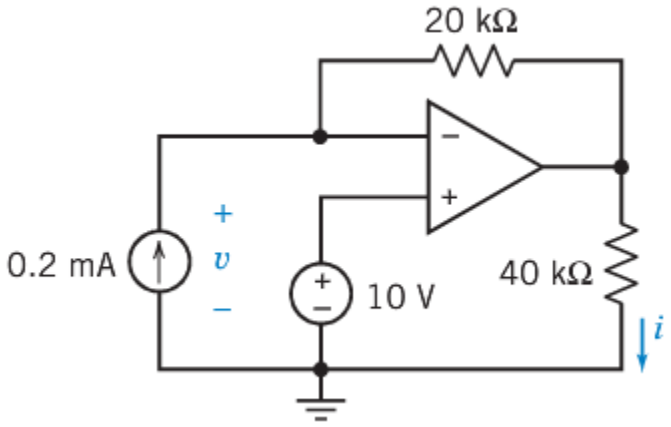
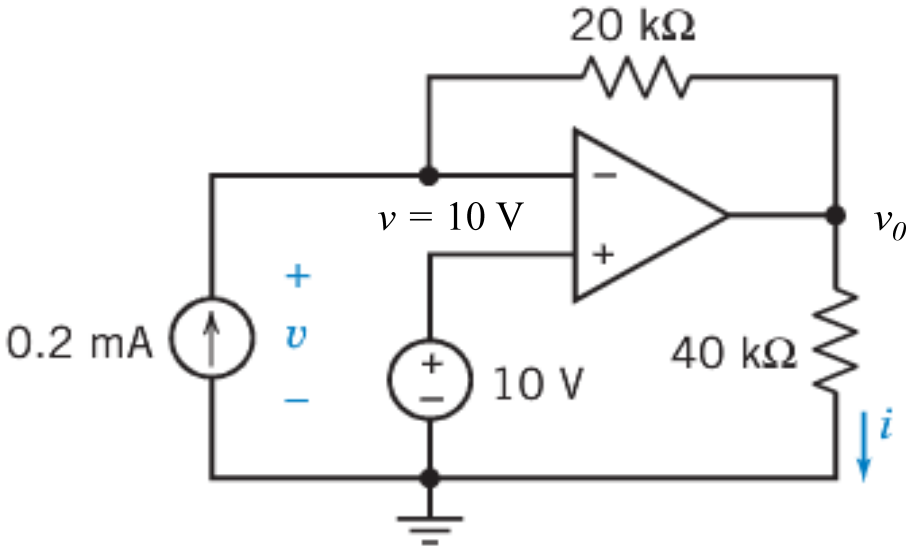


Figure P4



$v = 10$ V

KCL at inverting input terminal:

$$\frac{v_0 - 10}{20k} + 0.2m = 0$$

multiply both sides by 20k yields:

$$v_0 - 10 + 4 = 0$$

$$\boxed{v_0 = 6 \text{ V}}$$

$$i = \frac{v_0}{40k} = \frac{6}{40k} = 0.15 \text{ mA}$$