Eastern Mediterranean University

"For Your International Career"

Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

INFE221 – Electrical Circuits

Midterm Exam
Fall 2016-17

16 November 2016
Duration: 90 minutes

Instructor: M. K. Uyguroğlu

STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO.	

Problem		**Points**
1		20
2		60
3		20
TOTAL		100

Problem 1

A current source and a voltage source are connected in series with a resistor as shown in Figure P1. Suppose that V_s = 10 V, I_s = 2 A, and R = 5 Ω.

(a) Calculate the voltage v across the resistor and the power absorbed by the resistor.
(b) Calculate the voltage v_1 across the current source and the power supplied by the sources.
(c) Change the voltage source voltage to V_s = 5 V and recalculate the voltage, v, across the resistor and the power absorbed by the resistor.

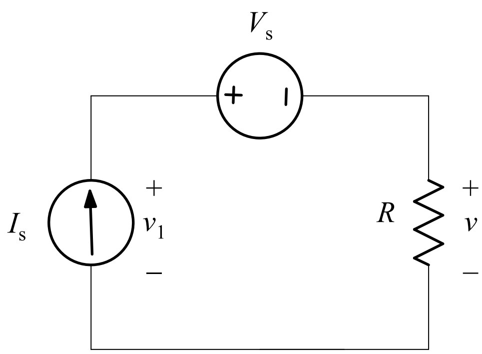


Figure P1

(a)

$$v = I_s R = 2 \times 5 = 10\,\text{V}$$
$$P_{5\Omega} = I_s v = 2 \times 10 = 20\,\text{W}$$

(b) KVL around the loop:

$$-v_1 + V_s + v = 0$$
$$v_1 = V_s + v = 10 + 10 = 20 \text{ V}$$
$$P_{I_s} = -2 \times 20 = -40 \text{ W absorbs} \Rightarrow 40 \text{ W supplies}$$
$$P_{V_s} = I_s V_s = 2 \times 10 = 20 \text{ W absorbs} \Rightarrow \text{-20 W supplies}$$

(c)

$$v = I_s R = 2 \times 5 = 10\,\text{V}$$
$$P_{5\Omega} = I_s v = 2 \times 10 = 20\,\text{W}$$

Problem 2

The circuit shown in Figure P2 has two inputs, v_s and i_s, and one output v_o. The output is related to the inputs by the equation

$$v_o = ai_s + bv_s$$

where a and b are constants to be determined. Determine the values a and b by

(a) writing and solving mesh equations (20 pts.)

(b) writing and solving node equations. (20 pts.)

(c) using superposition. (20 pts.)

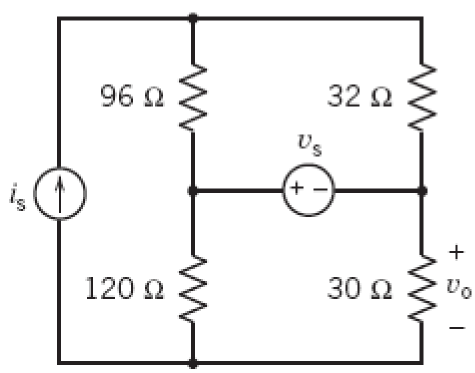
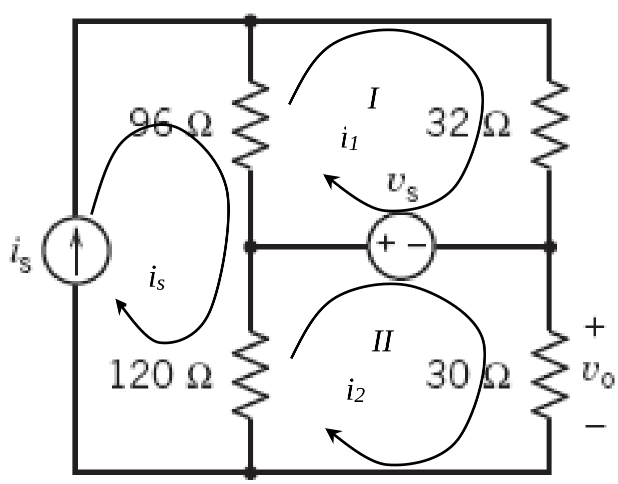


Figure P2

(a)



Since there is no resistor between mesh I and II, only one mesh equation is sufficient to find v_0 .

$v_o = 30i_2$

KVL around mesh II:

$120(i_2 - i_s) + v_s + 30i_2 = 0$

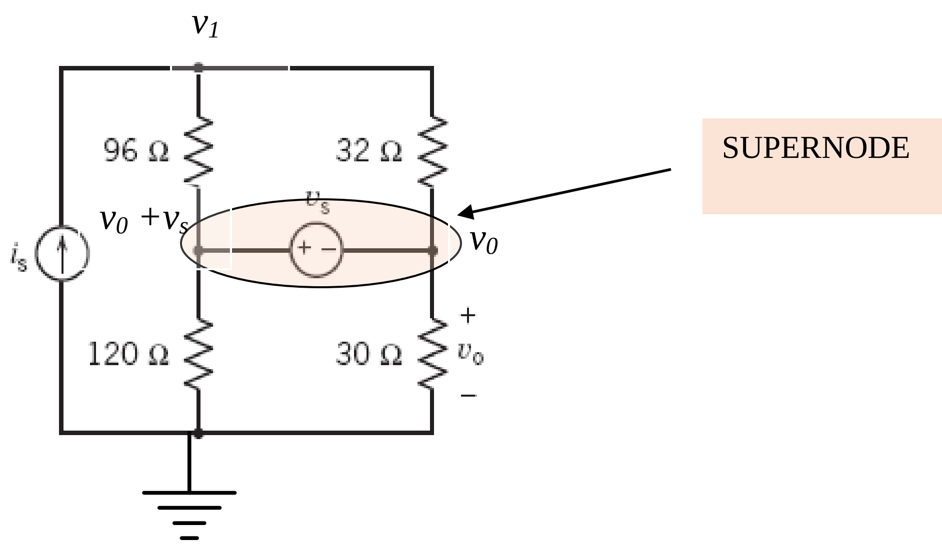
$150i_2 = 120i_s - v_s$

$i_2 = \frac{120}{150}i_s - \frac{1}{150}v_s$

$v_0 = 30i_2 = 24i_s - 0.2v_s$

$\therefore \boxed{a = 24, \quad b = -0.2}$

(b) Nodal Analysis



KCL at v_1 :

$\frac{v_1 - v_0 - v_s}{96} + \frac{v_1 - v_0}{32} = i_s$

Multiply both sides by 96 yields:

$v_1 - v_0 - v_s + 3v_1 - 3v_0 = 96i_s$

$4v_1 - 4v_0 = 96i_s + v_s$..................(1)

KCL at the SUPERNODE:

$$\frac{v_0+v_s}{120}+\frac{v_0+v_s-v_1}{96}+\frac{v_0}{30}+\frac{v_0-v_1}{32}=0$$

Multiply both sides by 480 yields:

$$4v_0+4v_s+5v_0+5v_s-5v_1+16v_0+15v_0-15v_1=0$$

$$40v_0-20v_1=-9v_s \text{.................}(2)$$

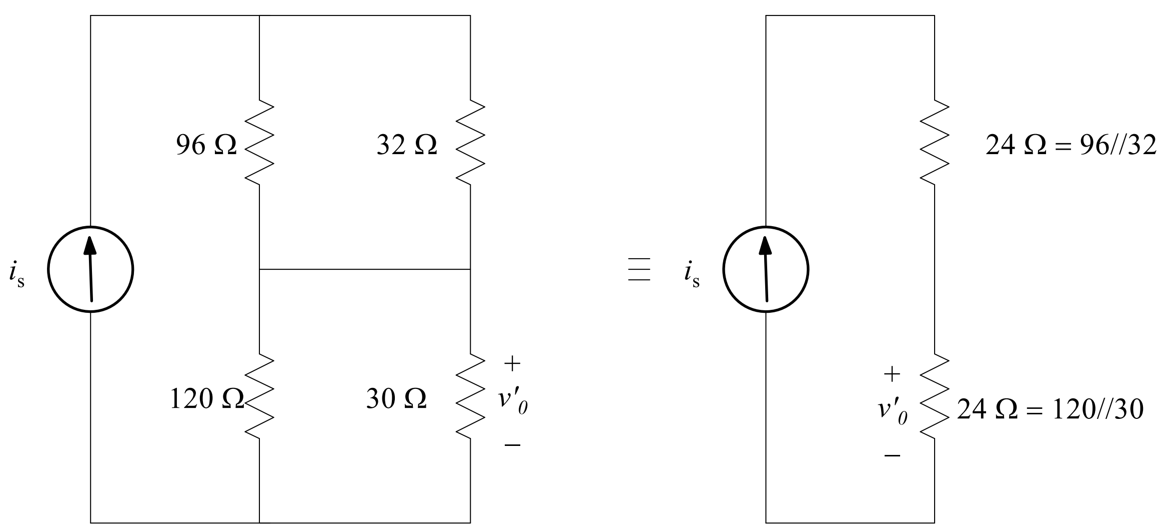
Multiply Eq.(1) by 5 and add to Eq. (2) gives:

$$20v_0=480i_s-4v_s$$

$$\boxed{v_0=24i_s-0.2v_s}$$

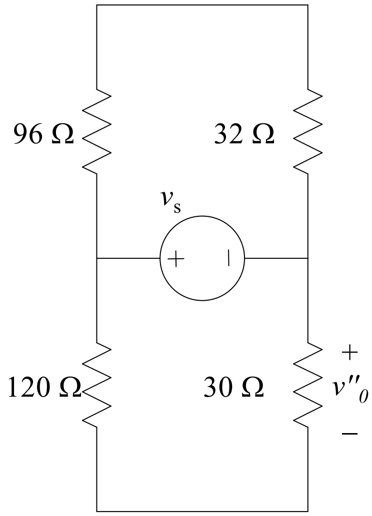
c) SUPERPOSITION

In order to find the contribution of i_s, set the voltage source value to zero.(**Replace the voltage source with short circuit**)



$$v_0'=24i_s$$

In order to find the contribution of v_s, set the current source value to zero.(**Replace the cuurent source with open circuit**)



Using voltage division principle:

$$v_0'' = -v_s \frac{30}{30+120} = -0.2v_s$$

Since

$$v_0 = v_0' + v_0''$$

then

$$\boxed{v_0 = 24i_s - 0.2v_s}$$

Problem 3

Find the Thévenin equivalent circuit for the circuit shown in Figure P3.

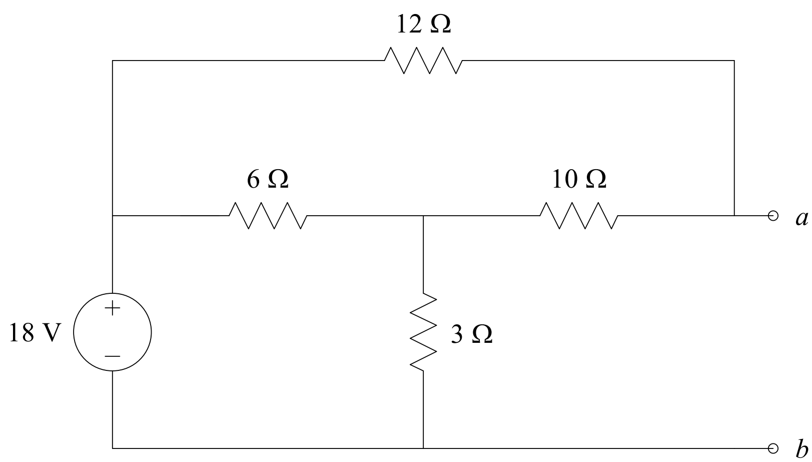
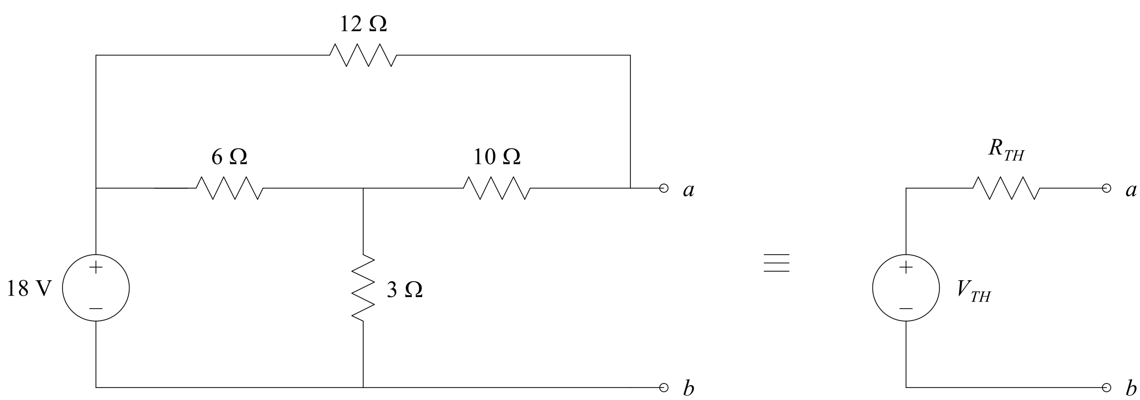


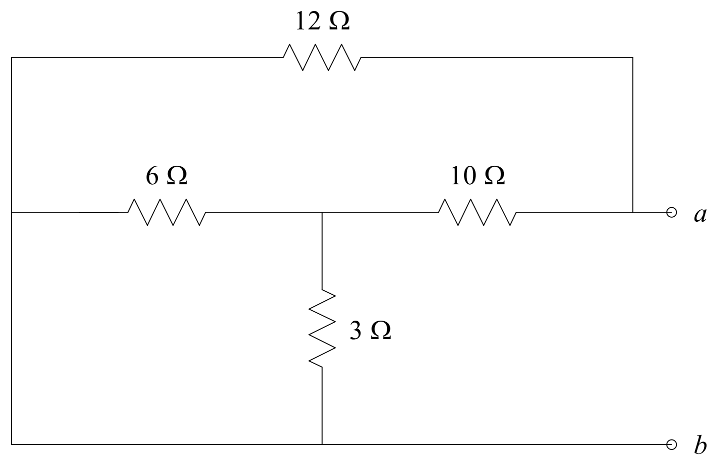
Figure P3



In order to find R_{TH} set all independent source values to zero. (Replace current sources with open circuits and voltage sources with short circuits.

$$30v_{oc} = 360$$

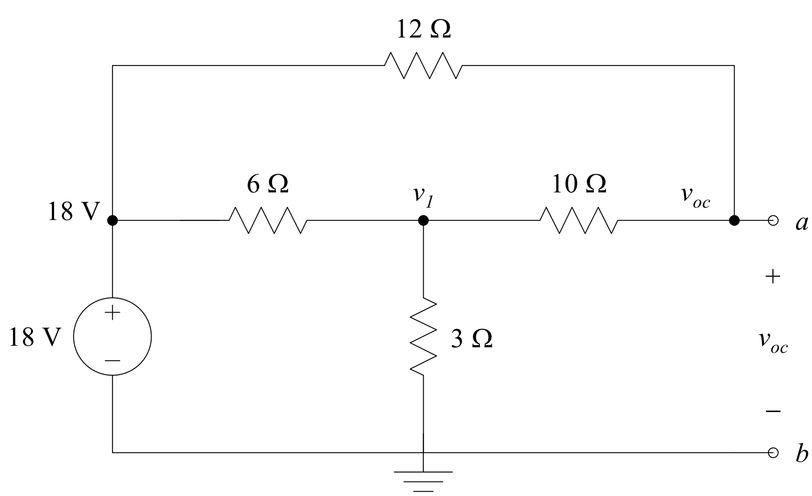
$$v_{oc} = \frac{360}{30} = 12\ \text{V}$$



$$R_{TH} = (6//3+10)//12 = \left(\frac{6\times 3}{6+3}+10\right)//12 = 12//12 = \frac{12\times 12}{12+12} = 6\Omega$$

2

In order to find V_{TH} , we will find the open circuit voltage v_{oc} between the terminals *a* and *b*.



KCL at v_{oc}

$$\frac{v_{oc}-v_1}{10}+\frac{v_{oc}-18}{12}=0$$

Multiply both sides by 60 yields:

$$6v_{oc}-6v_1+5v_{oc}-90=0$$

$$11v_{oc}-6v_1=90.................(1)$$

KCL at v_1

$$\frac{v_1-18}{6}+\frac{v_1}{3}+\frac{v_1-v_{oc}}{10}=0$$

Multiply both sides by 30 yields:

$$5v_1-90+10v_1+3v_1-3v_{oc}=0$$

$$-3v_{oc}+18v_1=90..............(2)$$

Multiply Eq. (1) by 3 and add to Eq. (2) gives:

$$30v_{oc}=360$$

$$\boxed{v_{oc}=12\text{ V}=V_{TH}}$$