Eastern Mediterranean University

"For Your International Career"

Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I

Midterm Exam
Spring 2015-16

18 April 2016
Duration: 100 minutes

Instructor: M. K. Uyguroğlu

STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO.	

Problem		**Points**
1		25
2		25
3		25
4		25
TOTAL		100

Problem 1

Find V_0 in Fig. P1 using nodal analysis.

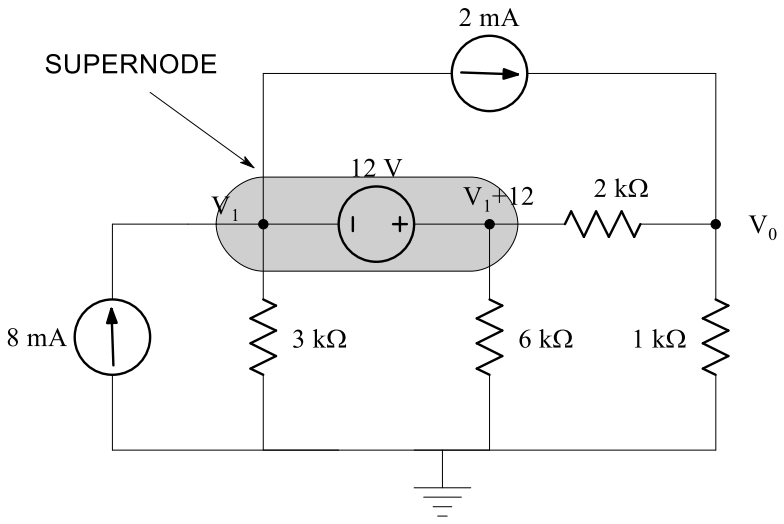


Figure P1

KCL at the SUPERNODE:

$$\frac{V_1}{3k}+\frac{V_1+12}{6k}+\frac{V_1+12-V_0}{2k}-8m+2m=0$$

Multiply both sides of the above equation by $6k$*:*

$$2V_1+V_1+12+3V_1+36-3V_0-48+12=0$$
$$6V_1-3V_0=-12.....(1)$$

KCL at V_0 :

$$\frac{V_0-V_1-12}{2k}+\frac{V_0}{1k}=2m$$

Multiply both sides by $2k$:

$$V_0-V_1-12+2V_0=4$$
$$-V_1+3V_0=16.....(2)$$

Multiplication of Eq.(2) by 6 and addition to Eq.(1) yields:

$$15V_0 = 84$$

$$\boxed{V_0 = \frac{84}{15} = 5.6\,\text{V}}$$

Problem 2

Use mesh analysis to find I_0 in the circuit in Fig. P2.

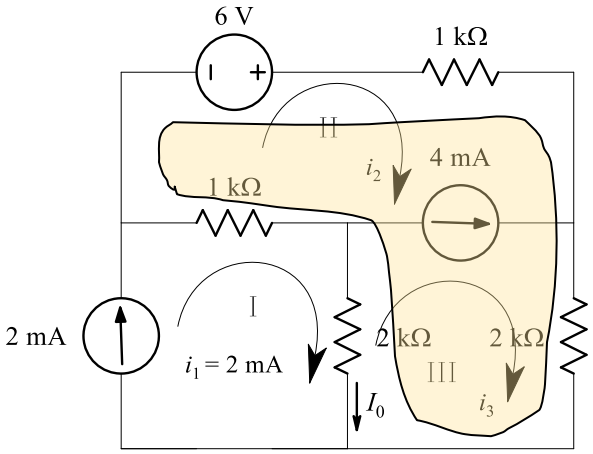


Figure P2

$i_3 - i_2 = 4m \Rightarrow \boxed{i_3 = i_2 + 4m}$

There are 3 meshes and 2 current sources. This implies that only one KVL Equation will be written. Mesh II and Mesh III constitute a supermesh. Therefore KVL will be written around the SUPERMESH.

$$-6 + 1k i_2 + 2k(i_2 + 4m) + 2k(i_2 + 4m - 2m) + 1k(i_2 - 2m) = 0$$

$$6k i_2 = 6 - 8 - 4 + 2 = -4$$

$$i_2 = -\frac{4}{6} mA$$

$$I_0 = i_1 - i_3 = 2m - (-\frac{4}{6}m + 4m) = -\frac{8}{6} mA$$

Problem 3

Use superposition to find V_0 in the circuit of Fig.P3.

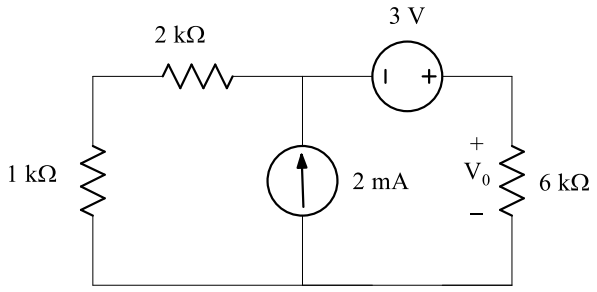
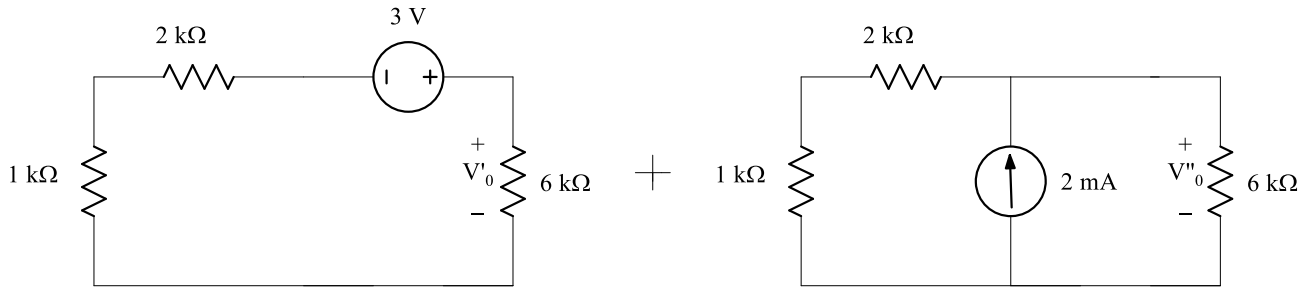


Figure P3



$$V_0 = V_0' + V_0''$$

Where

$V_0' = 3\dfrac{6k}{6k+1k+3k} = 2V$ (using voltage division principle)

And using current division principle the current flowing through $6k\Omega$ resistor can be found.

$V_0'' = \left(2m\dfrac{3k}{3k+6k}\right)6k = 4V$

Therefore

$\boxed{V_0 = 2+4 = 6V}$

Problem 4

Find the value of R_L for maximum power transfer in the circuit in Fig. P4 and the maximum power that can be transferred to this load.

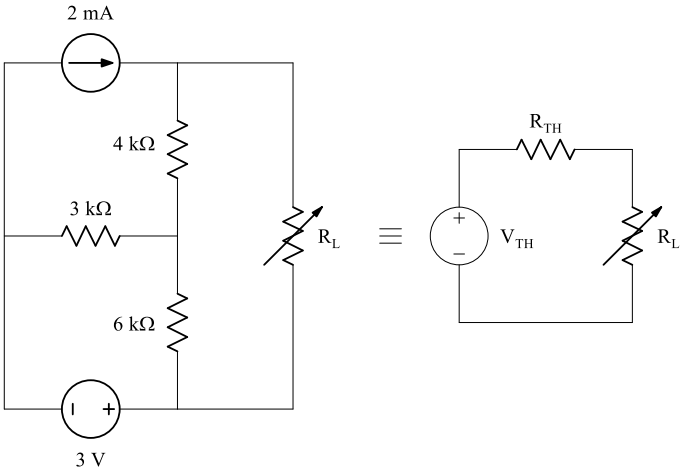
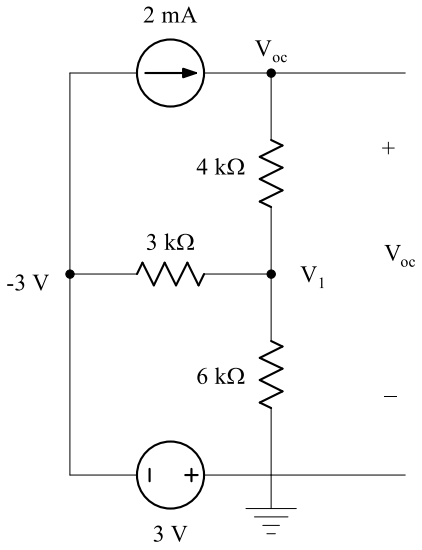


Figure P4

When $R_L = R_{TH}$ it will absorb maximum power.
Maximum power:

$$P_{\max} = \frac{V_{TH}^{\ 2}}{4R_{TH}}$$

In order to find R_{TH}, open circuit voltage will be found between the terminals of R_L .



KCL at V_{oc} :

$$\frac{V_{oc} - V_1}{4k} = 2m$$

or

$$V_{oc} - V = 8.....(1)$$

KCL at V_1 :

$$\frac{V_1 + 3}{3k} + \frac{V_1}{6k} + \frac{V_1 - V_{oc}}{4k} = 0$$

or

$$4V_1 + 12 + 2V_1 + 3V_1 - 3V_{oc} = 0$$

$$9V_1 - 3V_{oc} = -12.....(2)$$

Multiplication of Eq.(1) by 9 and addition to Eq.(2) gives:

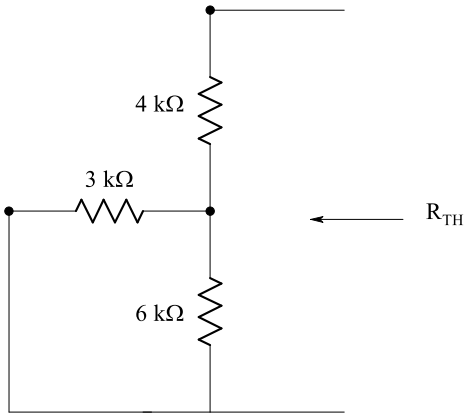
$6V_{oc} = 60$

$\boxed{V_{oc} = 10 \text{ V}}$

Since $V_{TH} = V_{oc}$

$\boxed{V_{TH} = 10 \text{ V}}$

In order to find R_{TH}, All independent source values are set to 0. (Replace voltage source with short and current source with open circuit)



$$R_{TH} = 4k + 3k\,//\,6k = 4k + \frac{3k \times 6k}{3k + 6k} = 6k$$

Therefore when $R_L = 6k\Omega$ then

$$P_{\max} = \frac{10^2}{4 \times 6k} = \frac{100}{24k} = 4.167 \text{ mW}$$