



# Eastern Mediterranean University

*"For Your International Career"*

Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

**INFE221 – Electrical Circuits**

**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.

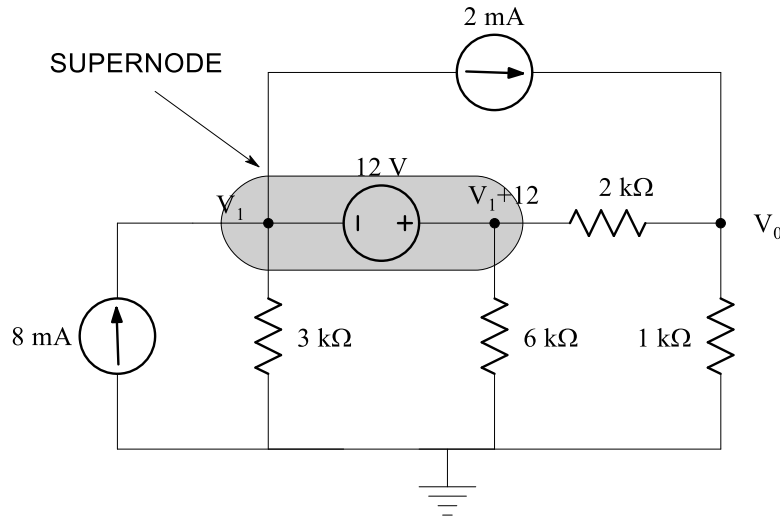


Figure P1

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  $6k$ :

$$2V_1 + V_1 + 12 + 3V_1 + 36 - 3V_0 - 48 + 12 = 0$$

$$6V_1 - 3V_0 = -12 \dots \dots (1)$$

KCL at  $V_0$  :

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

Multiply both sides by  $2k$  :

$$V_0 - V_1 - 12 + 2V_0 = 4$$

$$-V_1 + 3V_0 = 16 \dots \dots (2)$$

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

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$$15V_0 = 84$$

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

**Problem 2**

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

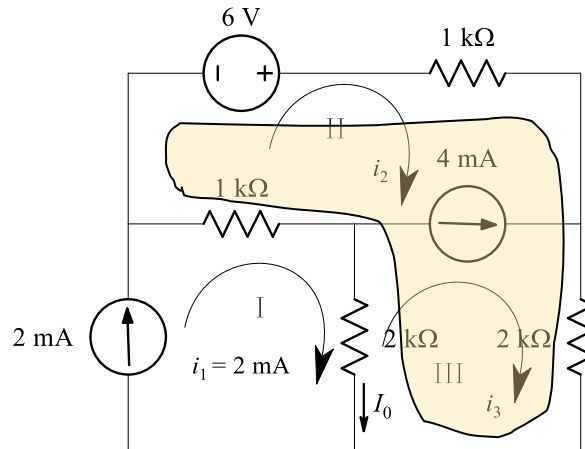


Figure P2

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

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.

$$-6 + 1ki_2 + 2k(i_2 + 4m) + 2k(i_2 + 4m - 2m) + 1k(i_2 - 2m) = 0$$

$$6ki_2 = 6 - 8 - 4 + 2 = -4$$

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

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

**Problem 3**

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

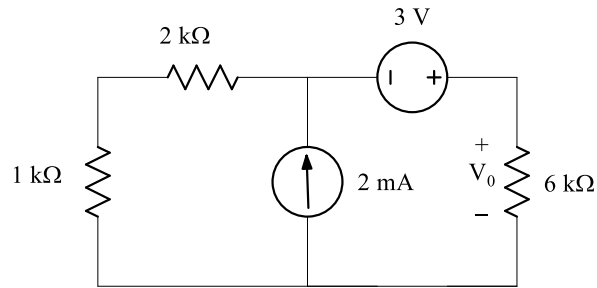
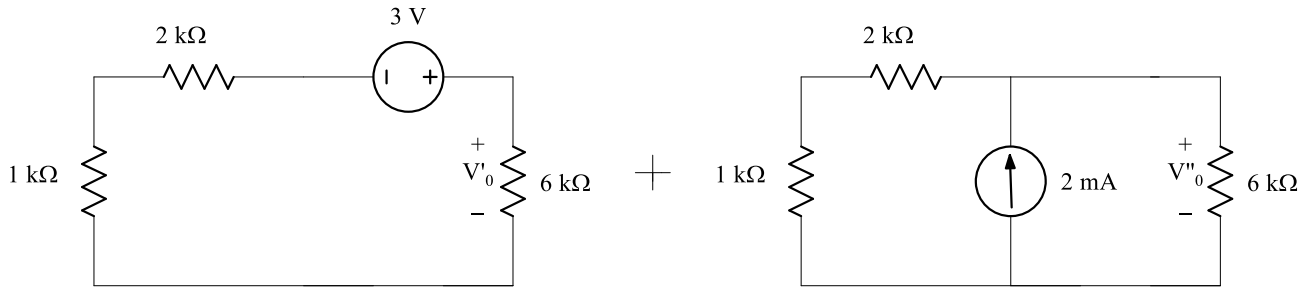


Figure P3



$$V_0 = V'_0 + V''_0$$

Where

$$V'_0 = 3 \frac{6k}{6k + 1k + 3k} = 2V \text{ (using voltage division principle)}$$

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

$$V''_0 = \left( 2m \frac{3k}{3k + 6k} \right) 6k = 4V$$

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.

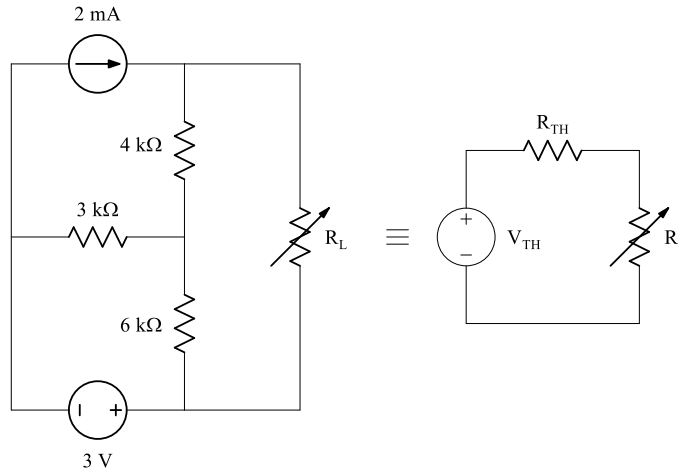


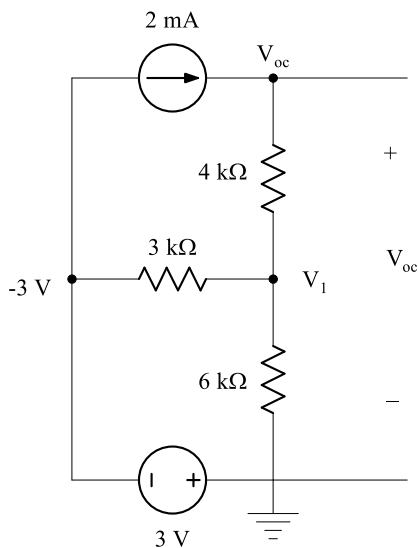
Figure P4

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

$$V_{oc} - V_1 = 8 \dots \dots (1)$$

KCL at  $V_1$  :

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

or

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

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

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

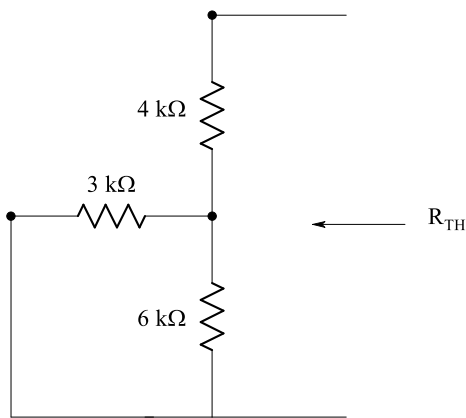
$$6V_{oc} = 60$$

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

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

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