Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I
INFE221 – Electrical Circuits

FALL 2008-09

Instructor:

M. K. Uyguroğlu

Midterm EXAMINATION

December 02, 2008

Duration : 90 minutes

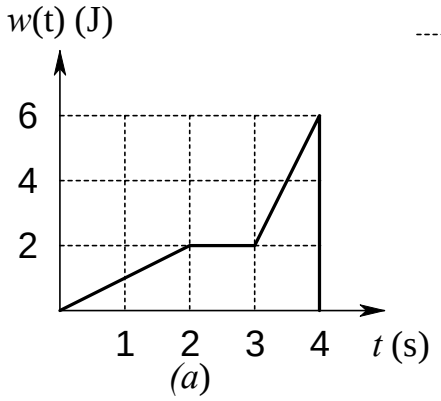
Number of Problems: 5

Good Luck

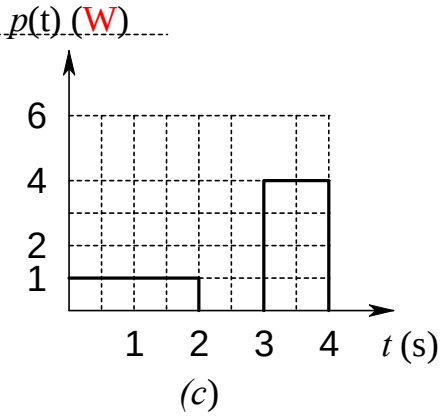
STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO	

Problem		**Points**
1		20
2		20
3		20
4		20
5		20
TOTAL		100

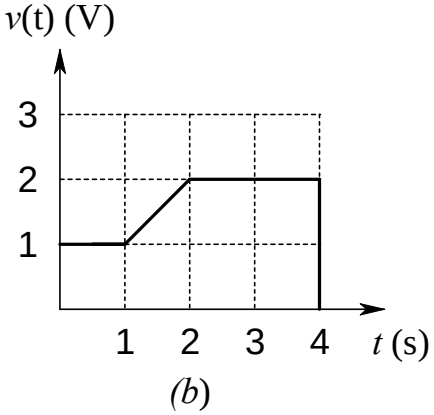
1. The energy $w(t)$ absorbed by an electrical device and the voltage $v(t)$ across it are shown in diagrams (a) and (b) below. In the diagram (c) and (d), sketch the corresponding power $p(t)$ absorbed by the device and current $i(t)$ through it, for a period of $0 < t < 4$ seconds. Make sure to label your sketches appropriately.



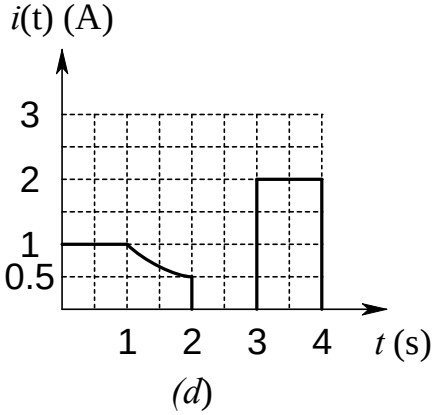
(a)



(c)



(b)



(d)

$$w(t) = \begin{cases} t & 0 < t < 2 \\ 2 & 2 < t < 3 \\ 4t - 10 & 3 < t < 4 \end{cases} \qquad p(t) = \frac{dw(t)}{dt} = \begin{cases} 1 & 0 < t < 2 \\ 0 & 2 < t < 3 \\ 4 & 3 < t < 4 \end{cases}$$

$$i(t) = \frac{p(t)}{v(t)} = \begin{cases} 1 & 0 < t < 1 \\ \frac{1}{t} & 1 < t < 2 \\ 0 & 2 < t < 3 \\ 2 & 3 < t < 4 \end{cases}$$

Find the total current i_T, branch current i_{bc}, and the open-circuit voltage v_{ac} in the circuit of Fig.P2.

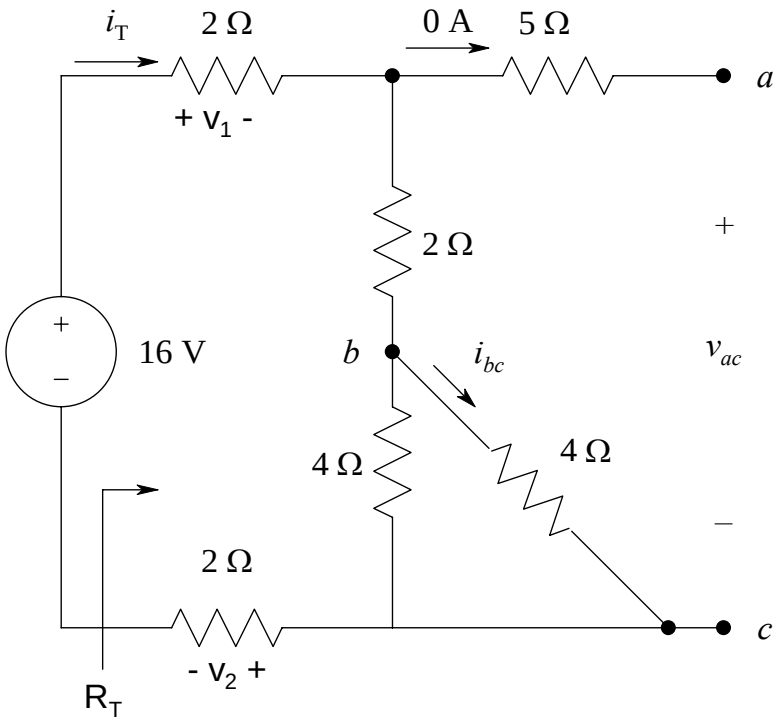


Figure P2

$$i_T = \frac{16}{R_T}$$

$$R_T = 2 + 2 + 4 // 4 + 2 = 8\Omega$$

$$i_T = \frac{16}{8} = 2 \text{ A}$$

Using current division principle:

$$i_{bc} = i_T \frac{4}{4+4} = 2 \times \frac{1}{2} = 1 \text{ A}$$

KVL around the outer loop:

$$-16 + \underbrace{v_1}_{4\text{V}} + v_{ac} + \underbrace{v_2}_{4\text{ V}} = 0$$

$$v_{ac} = 8 \text{ V}$$

2. For the circuit in Fig. P3, find i_x using nodal analysis.

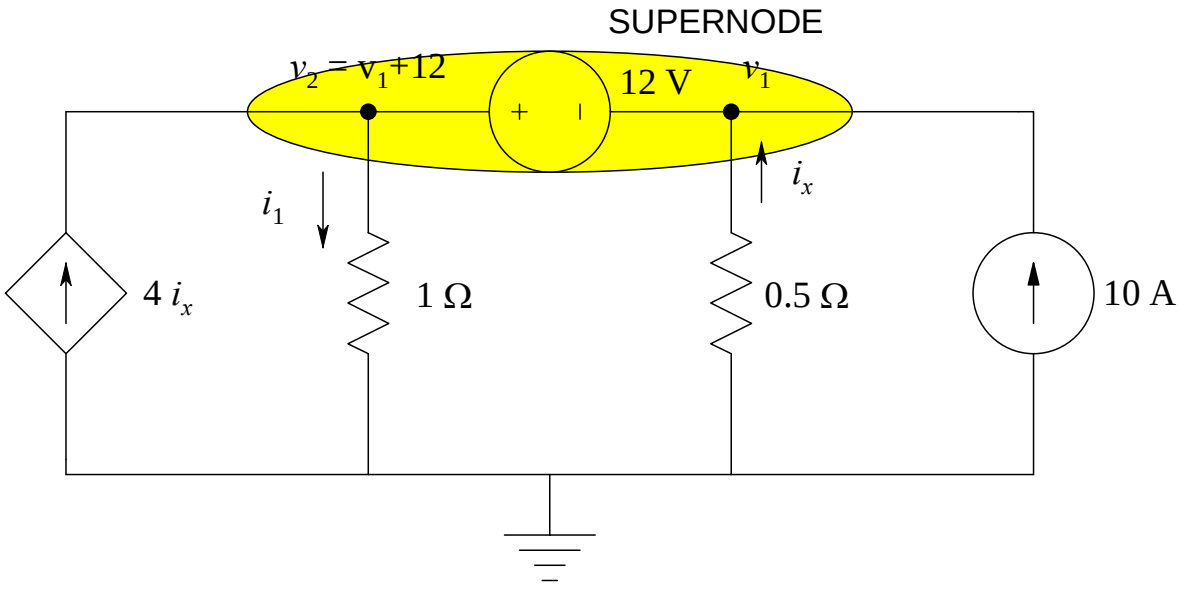


Figure P3

$$i_x = -\frac{v_1}{0.5}$$

KCL at the SUPERNODE:

$$i_1 - 4i_x - i_x = 10$$

$$i_1 - 5i_x = 10$$

$$i_1 = \frac{v_1 + 12}{1}$$

$$\frac{v_1 + 12}{1} - 5\left(-\frac{v_1}{0.5}\right) = 10$$

multiply both sides by 2 yields:

$$2v_1 + 24 + 20v_1 = 20$$

$$22v_1 = -4$$

$$v_1 = -\frac{2}{11} \text{ V}$$

$$i_x = -\frac{v_1}{0.5} = \frac{4}{11} \text{ A}$$

3. Use mesh analysis to find the power dissipated in the dependent current source in the circuit in Fig.P4.

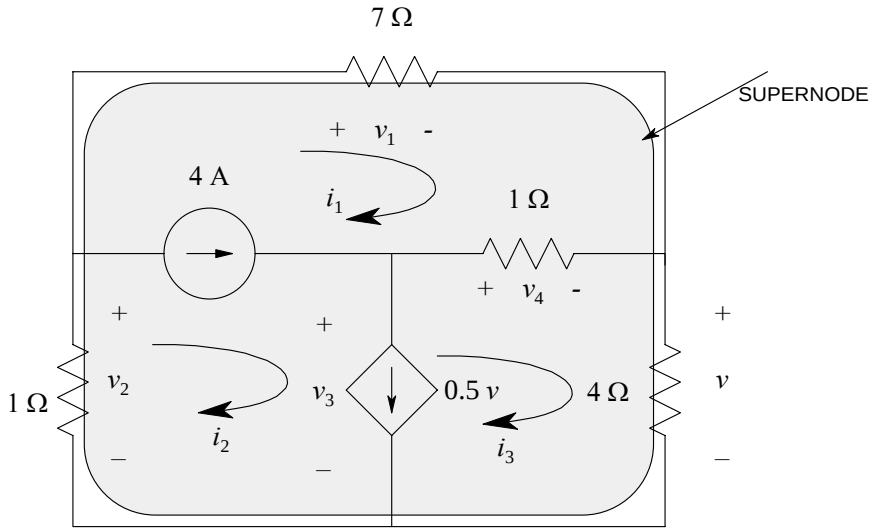


Figure P4

$P_{0.5v} = v_3 \times 0.5v$

$v = 4i_3$

$P_{0.5v} = 2v_3 \times i_3$

$i_2 - i_3 = 0.5v = 0.5 \times 4 \times i_3 = 2i_3$

$i_2 = 3i_3$

$i_2 - i_1 = 4$

$i_1 = i_2 - 4 = 3i_3 - 4$

KVL around the SUPERNODE:

$-v_2 + v_1 + v = 0$

$v_2 = -1(3i_3) = -3i_3$

$v_1 = 7(3i_3 - 4) = 21i_3 - 28$

$v = 4i_3$

$3i_3 + 21i_3 - 28 + 4i_3 = 0$

$28i_3 = 28$

$i_3 = 1 \text{ A}$

KVL around i_3:

$-v_3 + v_4 + v = 0 \Rightarrow v_3 = v_4 + v = 1(i_3 - i_1) + 4i_3 = i_3 - 3i_3 + 4 + 4i_3 = \underbrace{2i_3}_{2} + 4 = 6 \text{ V}$

$P_{0.5v} = 2 \times 6 \times 1 = 12 \text{ W}$

4. Use superposition to find v in the circuit in Fig. P5.

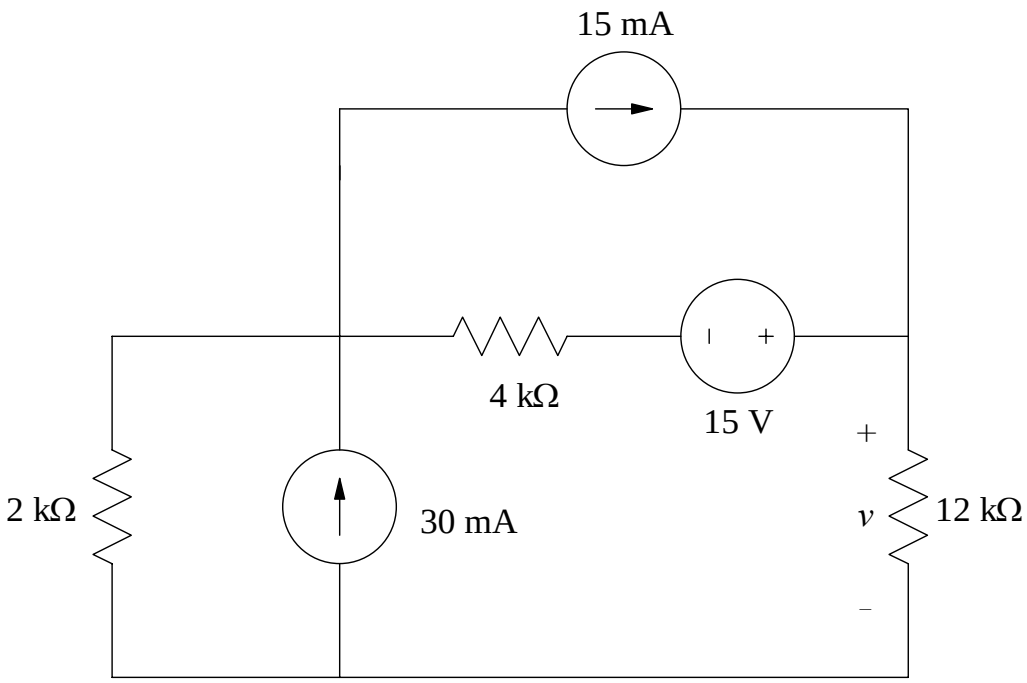
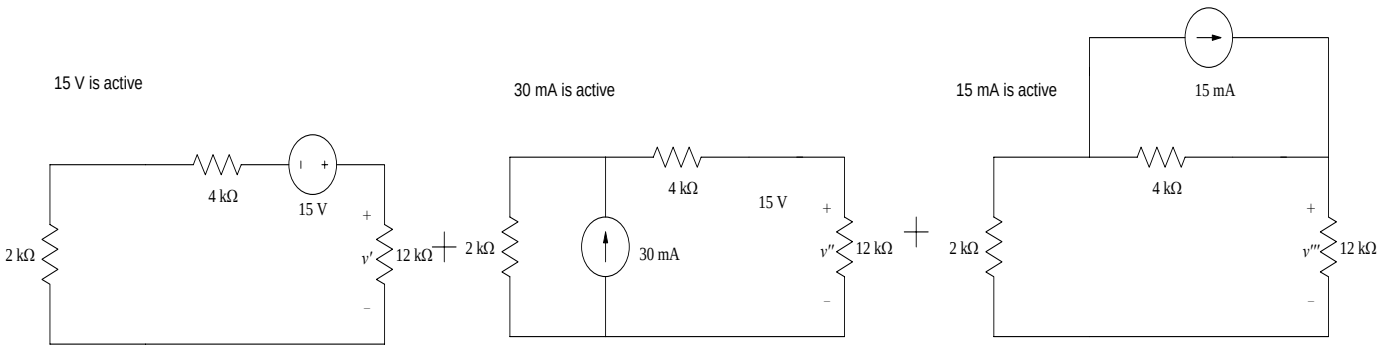


Figure P5



By using voltage division principle

$$v' = 15 \times \frac{12}{18} = 10 \text{ V}$$

By using current division principle and Ohm's Law:

$$v'' = 12k \times \left(30m \frac{2k}{18k} \right) = 40 \text{ V}$$

By using current division principle and Ohm's Law one more:

$$v''' = 12k \times \left(15m \frac{4k}{18k} \right) = 40 \text{ V}$$

$$v = v' + v'' + v'''$$

$$v = 10 + 40 + 40 = 90 \text{ V}$$