Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EEE 223 Circuit Theory I

Instructor:

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Midterm EXAMINATION

November 25, 2004

Duration : 90 minutes

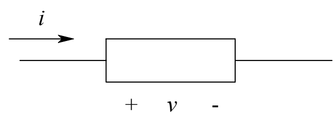
Number of Problems: 6

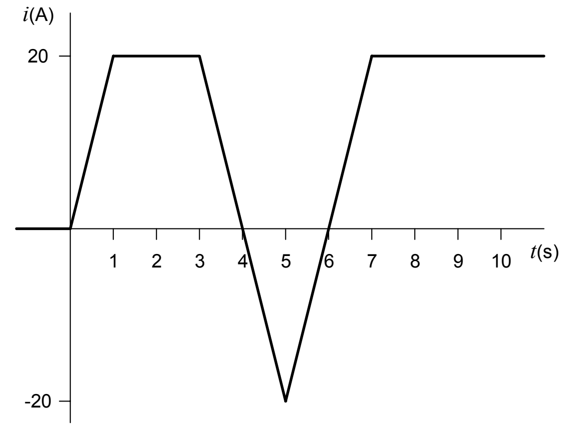
Good Luck

STUDENT'S	
NUMBER	
NAME	
SURNAME	

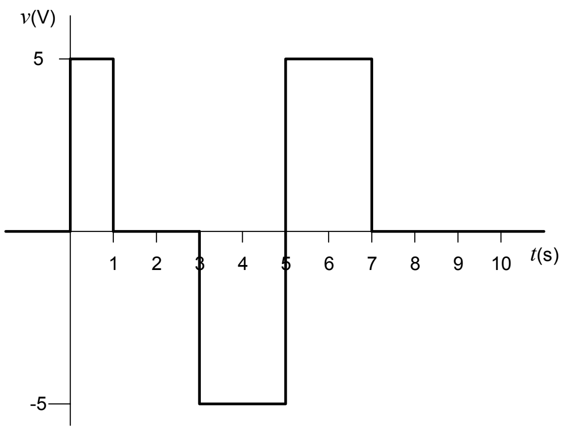
Problem		Points
1		20
2		15
3		20
4		15
5		15
6		15
TOTAL		100

1) The voltage and current at the terminals of the circuit element are shown in Fig. P1.
   a) Sketch the power versus t plot for $0 \le t \le 10$ s.
   b) Calculate the energy delivered to the circuit element at $t = 1, 6,$ and 10 s.



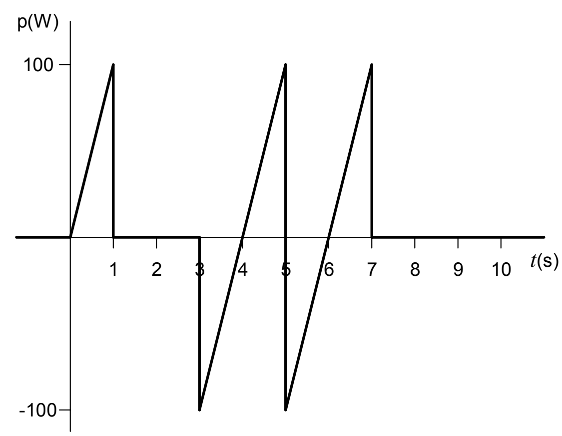


$$i(t) = \begin{cases} 20t & 0 < t < 1 \\ 20A & 1 < t < 3 \\ -20t + 80 & 3 < t < 5 \\ 20t - 120 & 5 < t < 7 \\ 20A & t > 7 \end{cases}$$



$$v(t) = \begin{cases} 5V & 0 < t < 1 \\ 0 & 1 < t < 3 \\ -5V & 3 < t < 5 \\ 5V & 5 < t < 7 \\ 0 & t > 7 \end{cases}$$

$$p(t) = \begin{cases} 100t & 0 < t < 1 \\ 0 & 1 < t < 3 \\ 100t - 400 & 3 < t < 5 \\ 100t - 600 & 5 < t < 7 \\ 0 & t > 7 \end{cases}$$



$$w(t) = \int_0^t p\,dt$$
$$w(1s) = 50J$$
$$w(6s) = 0J$$
$$w(10s) = 50J$$

2. The current in the 9Ω resistor in the circuit in Fig. P2 is 1 A, as shown.
   a) Find v_g
   b) Find the power dissipated in the 20Ω resistor.

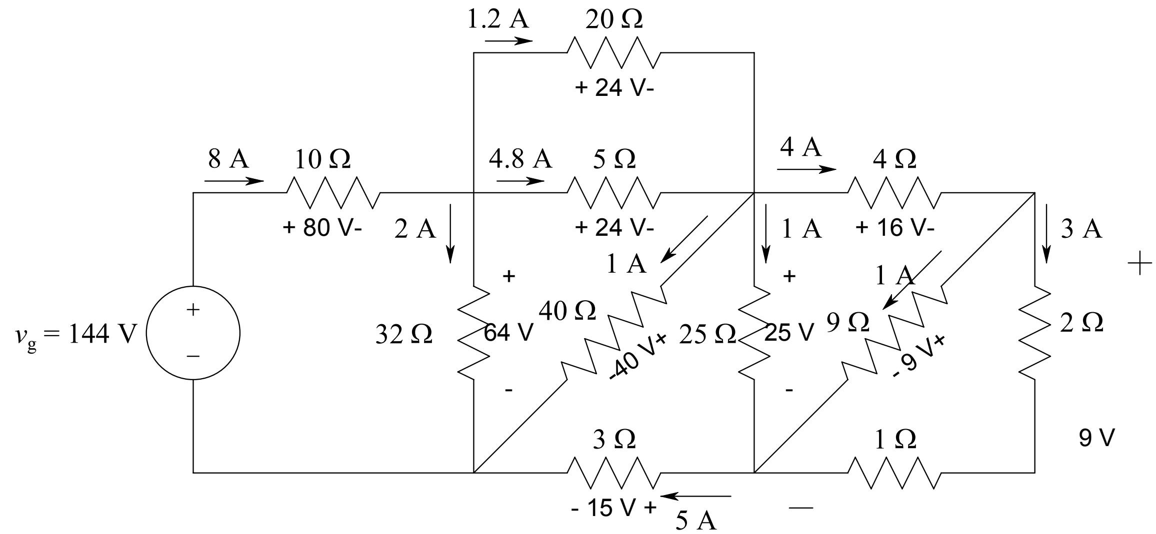


Figure P2

b) $p_{20\Omega} = 1.2 \times 24 = 28.8W$

3. Use the nodal analysis to find v in the circuit in Fig. P3.

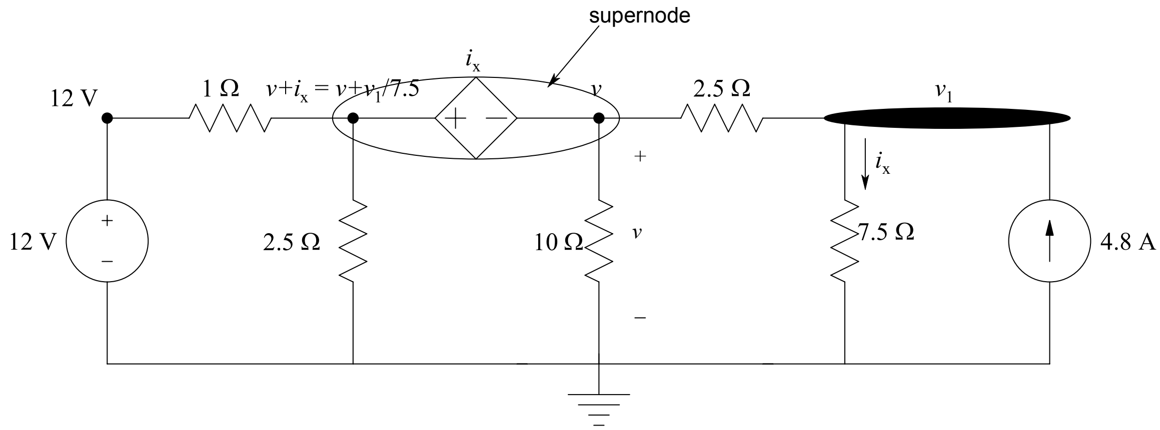


Figure P3

KCL at v_1:

$\left(\frac{1}{2.5}+\frac{1}{7.5}\right)v_1 - \frac{1}{2.5}v = 4.8$ multiply both sides of the equation by 7.5 yields:

$$4v_1 - 3v = 36 \qquad (1.1)$$

KCL at the supernode:

$\left(1+\frac{1}{2.5}\right)\left(v+\frac{v_1}{7.5}\right) - 12 + \left(\frac{1}{10}+\frac{1}{2.5}\right)v - \frac{1}{2.5}v_1 = 0$ multiply both sides of the equation by 10 yields:

$$14\left(v+\frac{v_1}{7.5}\right) - 120 + 5v - 4v_1 = 0$$

$$19v - \frac{16}{7.5}v_1 = 120 \qquad (1.2)$$

By using Eqns. (1.1) and (1.2) v can be obtained as:

$$v = 8\ V \qquad (1.3)$$

4. Use mesh analysis to find the power dissipated in the $1\,\Omega$ resistor in the circuit in Fig. P4.

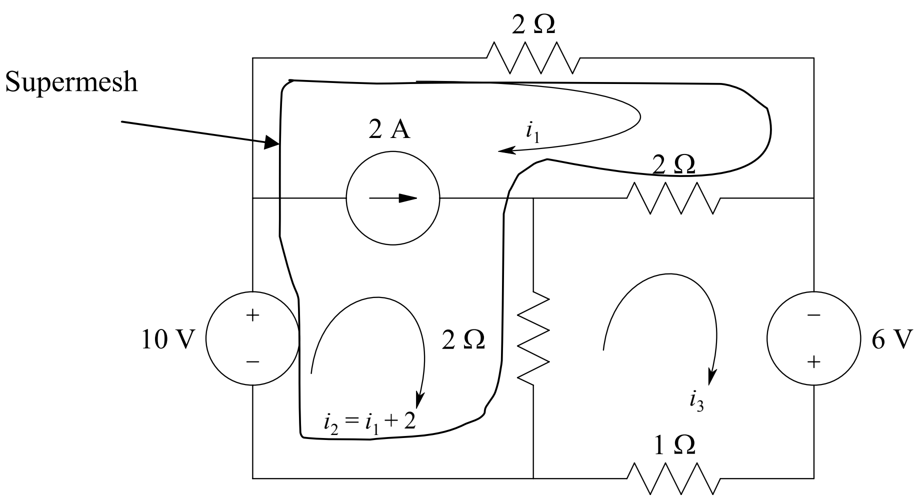


Figure P4

KVL around i_3:

$$\begin{aligned}(2+2+1)i_3 - 2(i_1+2) - 2i_1 &= 6 \\ 5i_3 - 4i_1 &= 10\end{aligned} \tag{1.4}$$

KVL around the supermesh:

$$\begin{aligned}(2+2)i_1 - 2i_3 + (2)(i_1+2) - 2i_3 &= 10 \\ -4i_3 + 6i_1 &= 6\end{aligned} \tag{1.5}$$

By using Eqns. (1.4) and (1.5) i_3 can be obtained as:

$$i_3 = 6\,A \tag{1.6}$$

Then the power dissipated by $1\,\Omega$ resistor is:

$$p_{1\Omega} = (i_3)^2 .1 = 36W \tag{1.7}$$

5. Find the Thevenin equivalent circuit with respect to the terminals *a, b* for the circuit in Fig. P5.

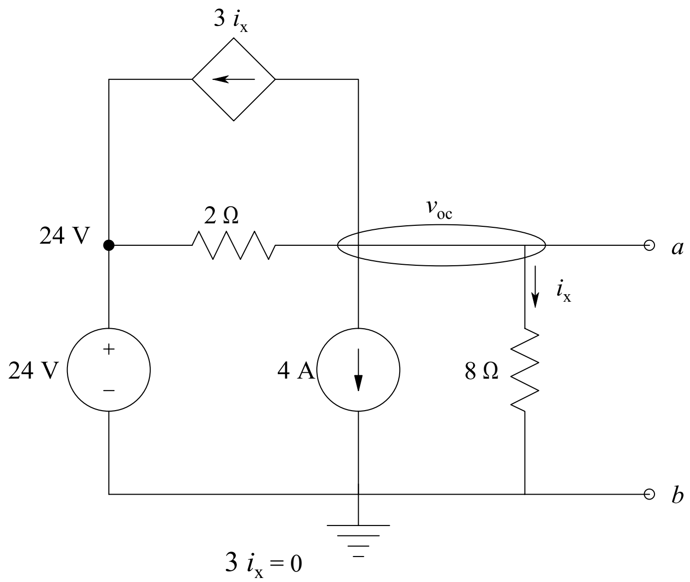
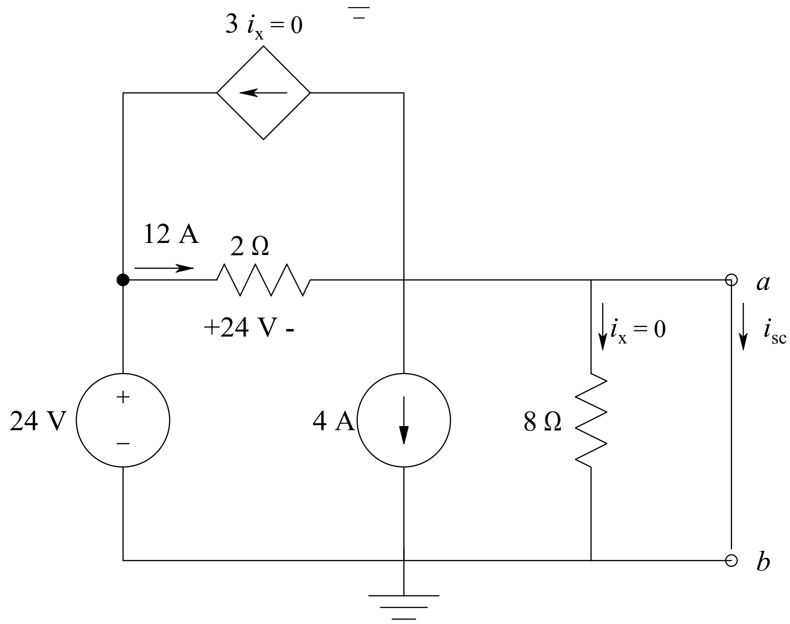


Figure P5

KCL at v_{oc} :

$$\left(\frac{1}{2}+\frac{1}{8}\right)v_{oc}-\frac{1}{2}.24=-4-3i_x=-4-3\frac{v_{oc}}{8}$$

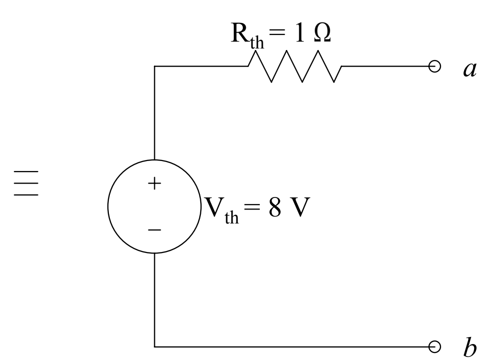
$$v_{oc}=8V=V_{th}$$



$$i_{sc}=12-4=8\,A$$

Therefore

$$R_{th}=\frac{v_{oc}}{i_{sc}}=\frac{8}{8}=1\Omega$$



6. Find v_0 in the op amp circuit in Fig.P6.

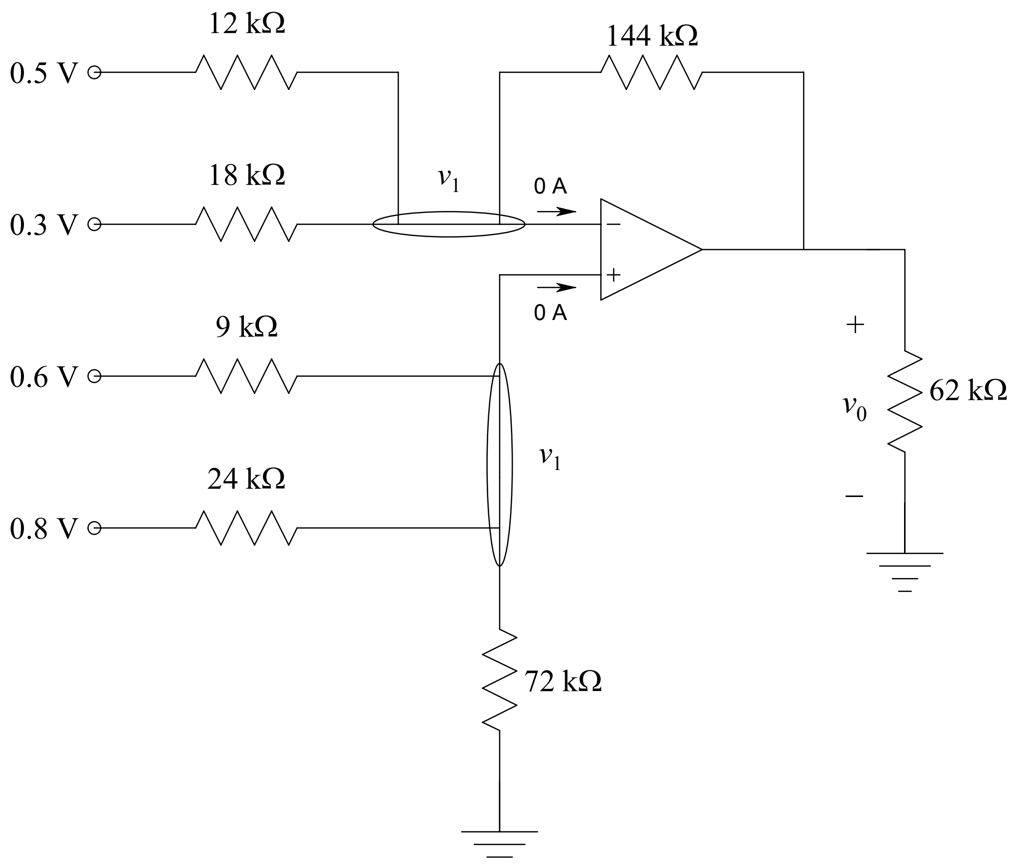


Figure P6

KCL at the non-inverting terminal:

$$\left(\frac{1}{9}+\frac{1}{24}+\frac{1}{72}\right)v_1-\frac{0.6}{9}-\frac{0.8}{24}=0$$

multiply both sides by 72 yields: (1.10)

$$12v_1 = 7.2$$

$$v_1 = 0.6V$$

KCL at the inverting terminal:

$$\left(\frac{1}{12}+\frac{1}{18}+\frac{1}{144}\right)v_1-\frac{0.5}{12}-\frac{0.3}{18}-\frac{v_0}{144}=0 \qquad (1.11)$$

$$v_0 = 21(0.6)-6-2.4=4.2\ \text{V}$$