Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I

Instructor:

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Midterm EXAMINATION

April 12, 2008

Duration :100 minutes

Number of Problems: 5

Good Luck

STUDENT'S	
NUMBER	
NAME	**SOLUTIONS**
SURNAME	

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

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

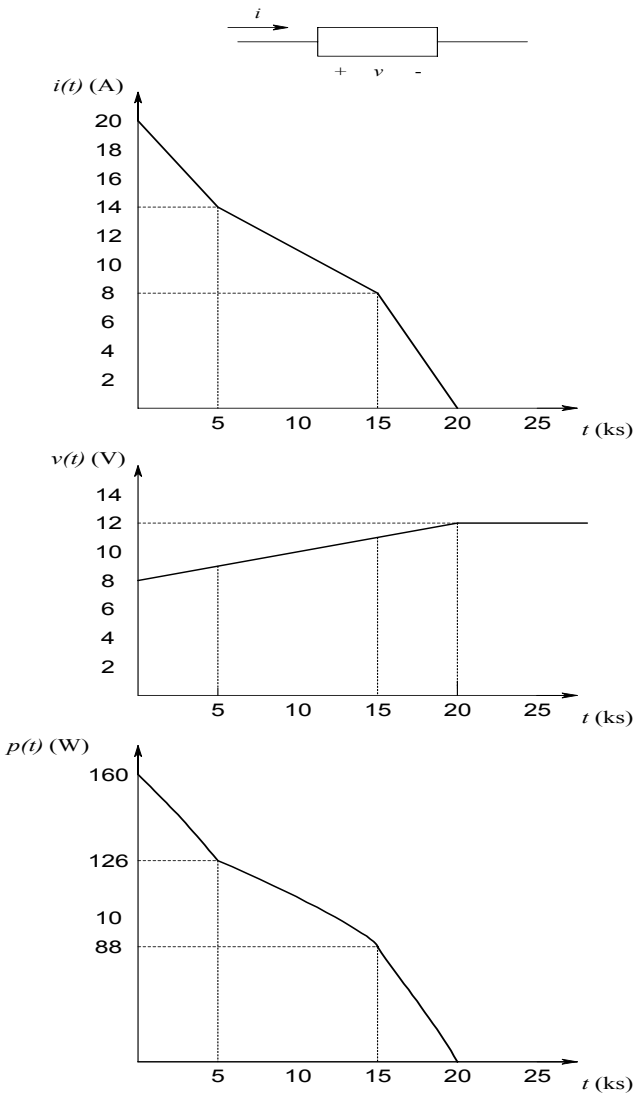


Figure P1

$$i(t) = \begin{cases} -\frac{6}{5}\times 10^{-3}t + 20 & 0 < t < 5ks \\ -\frac{6}{10}\times 10^{-3}t + 17 & 5ks < t < 15ks \\ -\frac{8}{5}\times 10^{-3}t + 32 & 15ks < t < 20ks \\ 0 & t > 20ks \end{cases}$$

$$v(t) = \begin{cases} \frac{4}{20}\times 10^{-3}t + 8 & 0 < t < 20ks \\ 12 & t > 20ks \end{cases}$$

$$q_T = \int_0^{20k} idt = \int_0^{5k} idt + \int_{5k}^{15k} idt + \int_{15k}^{20k} idt$$

$$q_T = 85k + 110k + 20k = 215kC$$

$$p(t) = \begin{cases} -\frac{24}{100}\times 10^{-6}t^2 - \frac{28}{5}\times 10^{-3}t + 160 & 0 < t < 5ks \\ -\frac{24}{200}\times 10^{-6}t^2 - \frac{14}{10}\times 10^{-3}t + 136 & 5ks < t < 15ks \\ -\frac{32}{100}\times 10^{-6}t^2 - \frac{32}{5}\times 10^{-3}t + 256 & 15ks < t < 20ks \\ 0 & t > 20ks \end{cases}$$

2) Use the nodal analysis to find *v* in the circuit in Fig. P2.

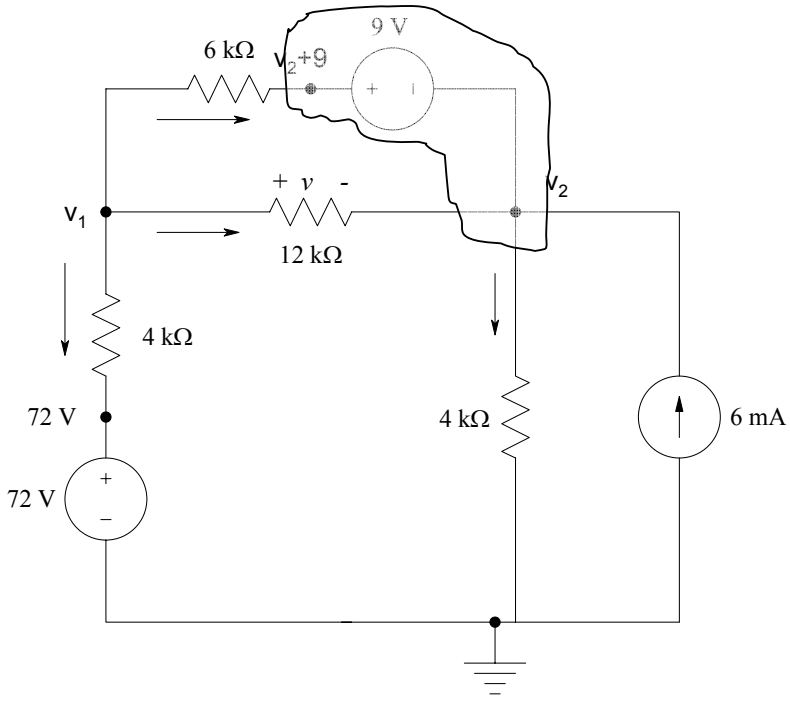


Figure P2

KCL at v_1 :

$$\frac{v_1-72}{4k}+\frac{v_1-v_2}{12k}+\frac{v_1-v_2-9}{6k}=0$$

multiply both sides by 12k yields:

$$3v_1-216+v_1-v_2+2v_1-2v_2-18=0$$

$$6v_1-3v_2=234$$

$$2v_1-v_2=78.....(1)$$

KCL at the SUPERNODE:

$$-\frac{v_1-v_2-9}{6k}-\frac{v_1-v_2}{12k}-6m+\frac{v_2}{4k}=0$$

multiply both sides by 12k gives:

$$-2v_1+2v_2+18-v_1+v_2-72+3v_2=0$$

$$-3v_1+6v_2=54.....(2)$$

Solving Eqns. (1) and (2) yields:

$$v_1=58V$$

$$v_2=38V$$

$$\therefore v=v_1-v_2=58-38=20V$$

3) Use mesh analysis to find the indicated variables in the circuit in Fig. P3.

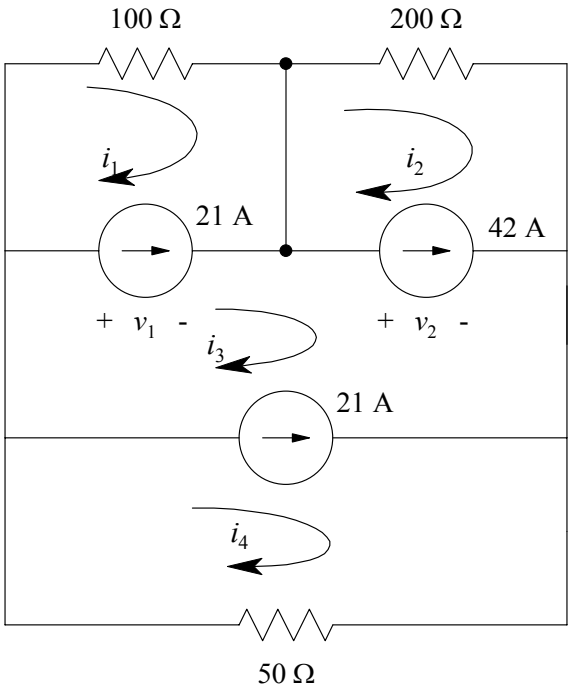
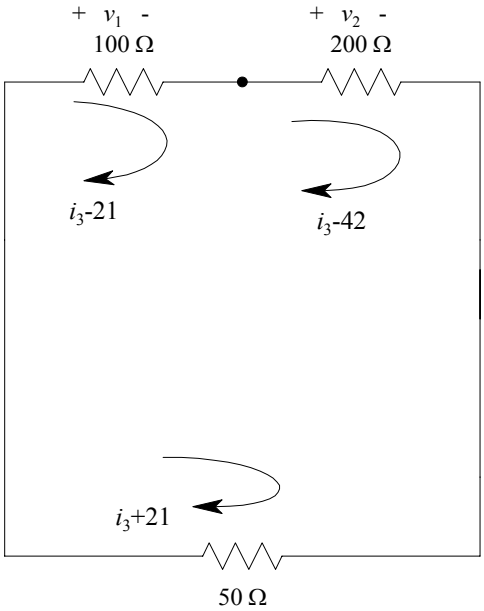


Figure P3

$$i_3 - i_1 = 21 \Rightarrow i_1 = i_3 - 21$$
$$i_3 - i_2 = 42 \Rightarrow i_2 = i_3 - 42$$
$$i_4 - i_3 = 21 \Rightarrow i_4 = i_3 + 21$$



KVL around the loop:

$$100(i_3 - 21) + 200(i_3 - 42) + 50(i_3 + 21) = 0$$
$$350 i_3 = 2100 + 8400 - 1050 = 9450$$
$$i_3 = 27A$$
$$v_1 = 100(i_3 - 21) = 600V$$
$$v_2 = 200(i_3 - 42) = -3000V$$

4) Use the principle of superposition to find v_0 in the circuit in Fig.P4.

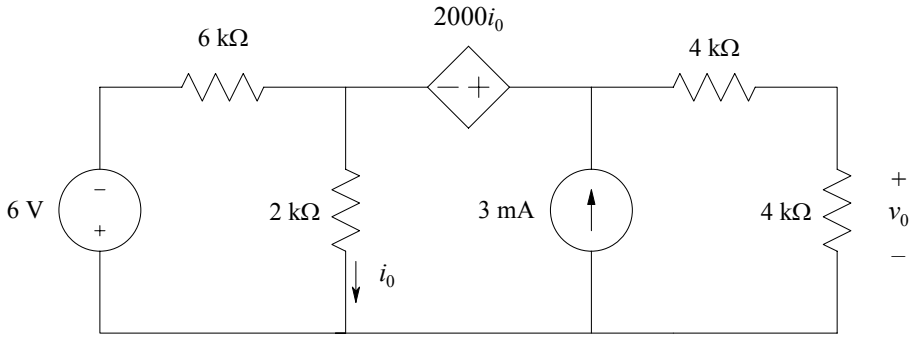
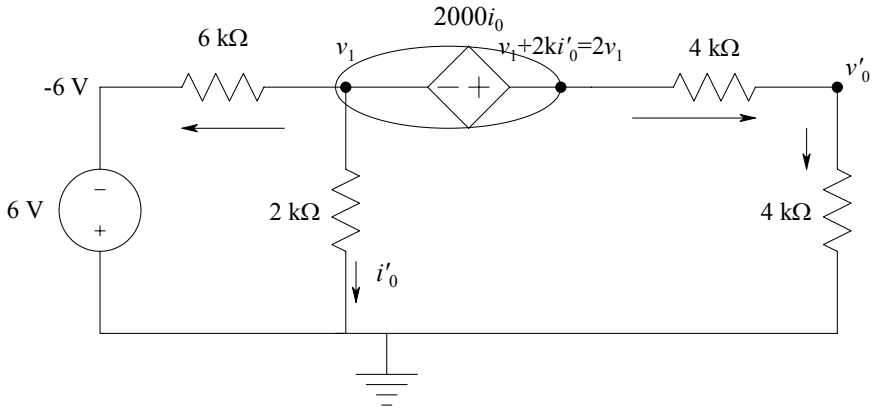


Figure P4

6 V Voltage source is active:



KCL at the SUPERNODE:

$$\frac{v_1+6}{6k}+\frac{v_1}{2k}+\frac{2v_1-v_0'}{4k}=0$$

Multiply both sides by 12k yields:

$$2v_1+12+6v_1+6v_1-3v_0'=0$$

$$14v_1-3v_0'=-12.....(1)$$

KCL at v_0':

$$-\frac{2v_1-v_0'}{4k}+\frac{v_0'}{4k}=0$$

Multiply both sides by 4k yields:

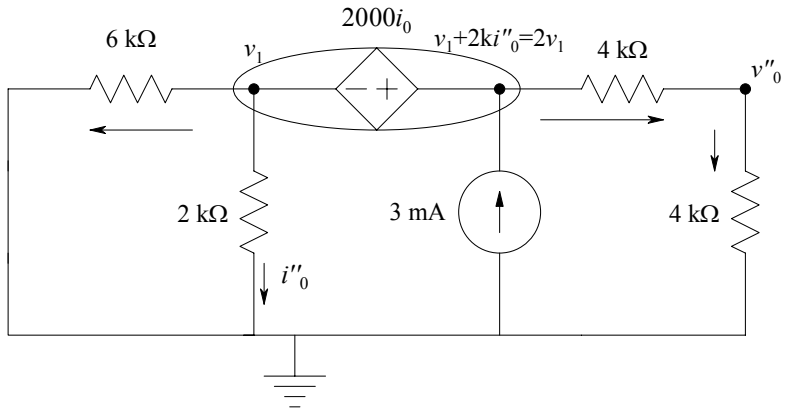
$$-2v_1+2v_0'=0$$

$$v_1=v_0'.....(2)$$

Using Eqns.(1) and (2)

$$v_0'=-\frac{12}{11}\ \text{V}$$

3 mA current source is active:



"KCL at the SUPERNODE:

$$\frac{v_1}{6k}+\frac{v_1}{2k}+\frac{2v_1-v_0''}{4k}=3m$$

Multiply both sides by 12k yields:

$$2v_1+6v_1+6v_1-3v_0''=36$$

$$14v_1-3v_0''=36.....(1)$$

KCL at v_0':

$$-\frac{2v_1-v_0''}{4k}+\frac{v_0''}{4k}=0$$

Multiply both sides by 4k yields:

$$-2v_1+2v_0''=0$$

$$v_1=v_0''.....(2)$$

Using Eqns.(1) and (2)

$$v_0''=\frac{36}{11}\ \text{V}$$

$$v_0=v_0'+v_0''=-\frac{12}{11}+\frac{36}{11}=\frac{24}{11}\ \text{V}$$

5) Find *v* in the circuit in Fig. P5 by using source transformation.

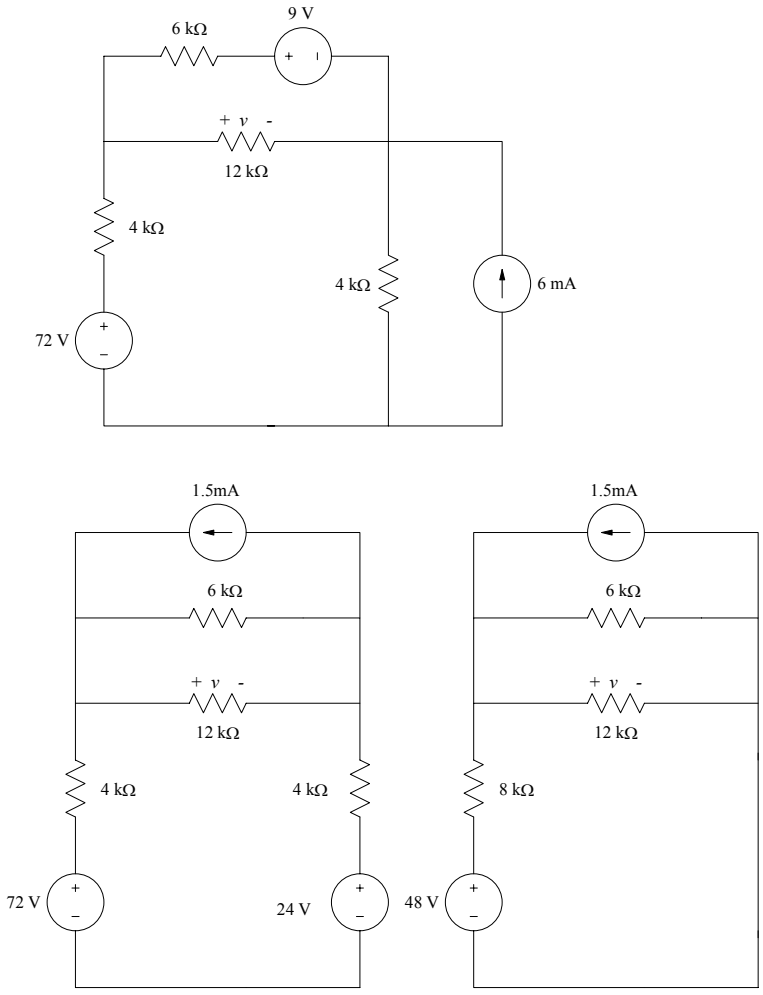
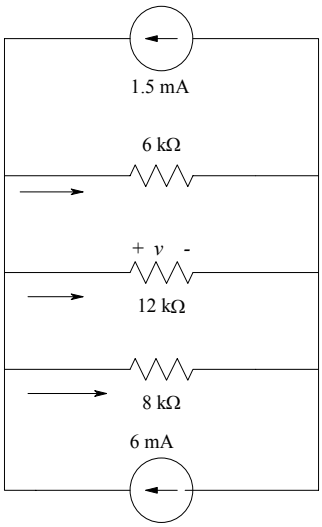


Figure P5



$$\frac{v}{6k}+\frac{v}{12k}+\frac{v}{8k}=7.5m$$

multiply both sides by 24k yields:

$$9v=180$$

$$v=20V$$