Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I

Fall 2006-07

Instructor:

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Midterm EXAMINATION

Nov 24, 2006

Duration : 100 minutes

Number of Problems: 4

Good Luck

STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO	

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

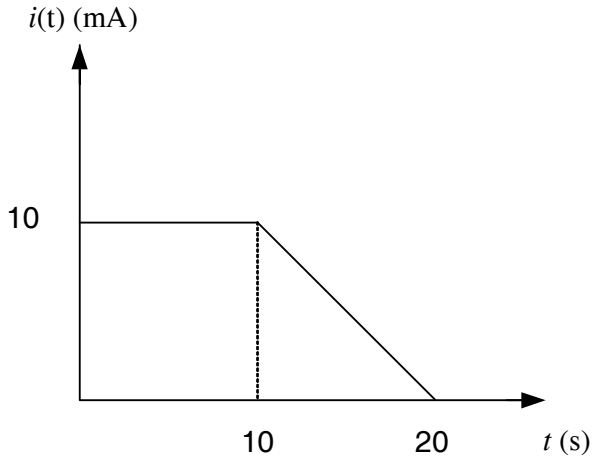
1. (*a*) The current that enters an element is shown in Fig.P1(*a*).
   a) Write the current expression between $0 < t < 20s$ (5 pts.)
   b) Find the charge that enters the element in the time interval $0 < t < 20s$. (5 pts.)

Figure P1(*a*)

$$i(t) = \begin{cases} 10\times10^{-3}\,A & 0 < t < 10s \\ (-t+20)\times10^{-3} & 10 < t < 20s \end{cases}$$

$$q(t) = \int_0^{20} i\,dt = \int_0^{10} 10\times10^{-3}\,dt + \int_{10}^{20} \left((-t+20)\times10^{-3}\right)dt$$

$$q(t) = 100\times10^{-3} + 50\times10^{-3} = 150mC$$



1. (*b*) Find R_{AB} in the circuit in Fig. P1(*b*). (5 pts.)

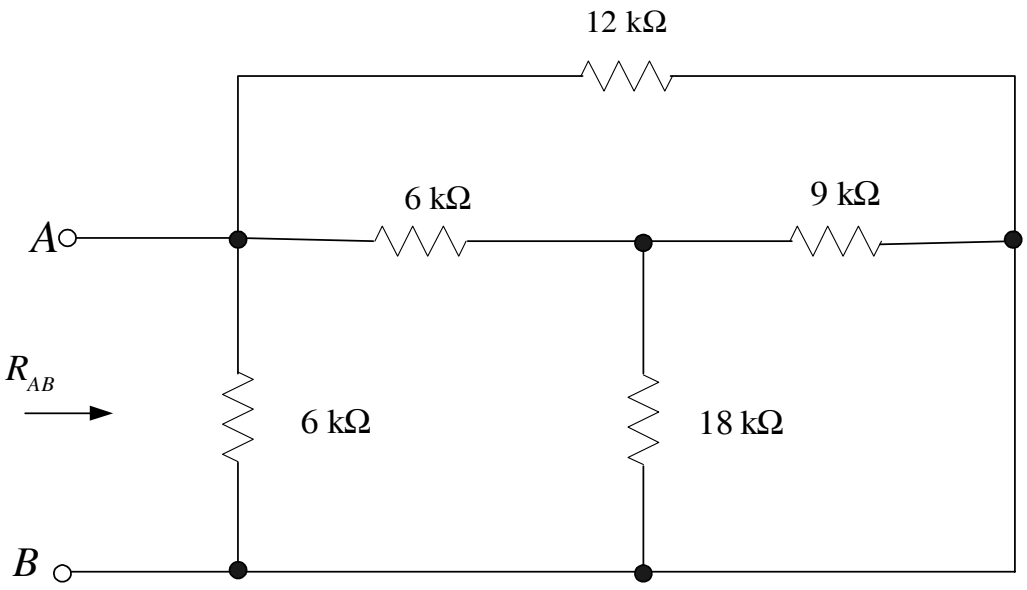


Figure P 1(b)

$$R_{AB} = 6k \,//\, \left(6k + 9k \,//\, 18k\right) //\, 12k$$
$$R_{AB} = 3k\Omega$$

1. (c) Combine sources and use the voltage division principle to find V_{ab} in the circuit in Fig.P1(c). (5 pts.)

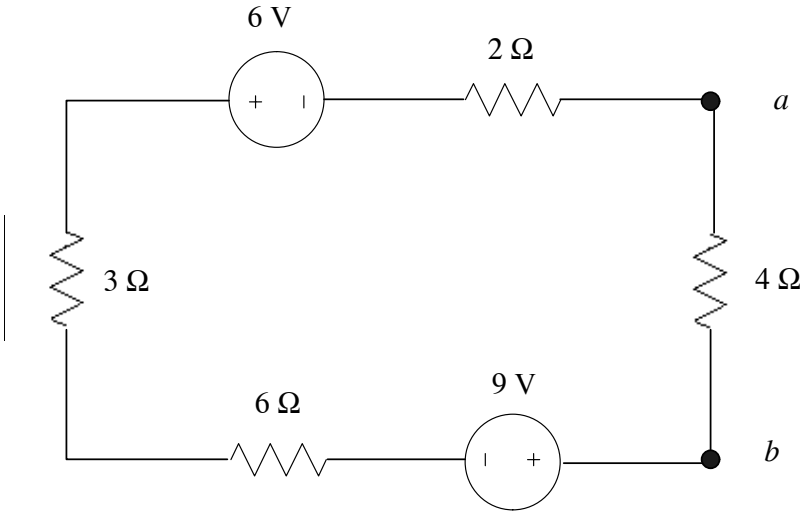


Figure P 1(c)

$$V_{ab} = -15\frac{4}{15} = -4V$$

1. (d) Use current division principle to find I_0 in the circuit in Fig. P1(d) and the power supplied by 12-mA current source. (5 pts.)

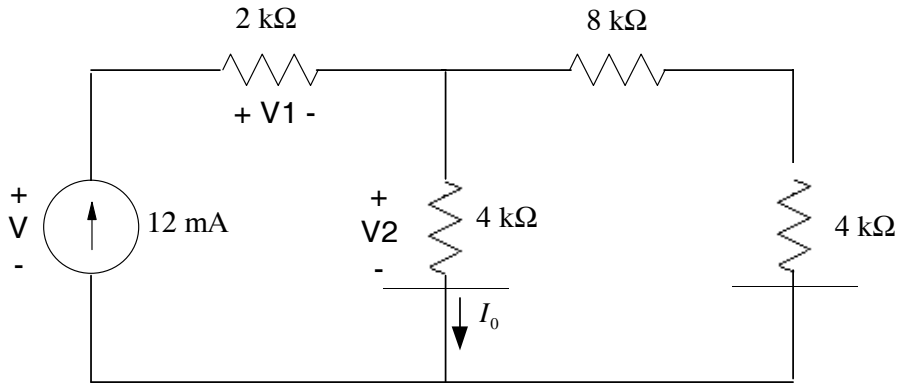


Figure P 1(d)

$$I_0 = 12m\frac{12k}{16k} = 9mA$$

$$V = V1 + V2 = 2k\left(12m\right) + 4k\left(9m\right) = 60V$$

$$P_{12mA} = -12\times10^{-3}\left(60\right) = -720mW \quad \text{supplied}$$

2. Use nodal analysis to find I_0 in the circuit in Fig. P2.

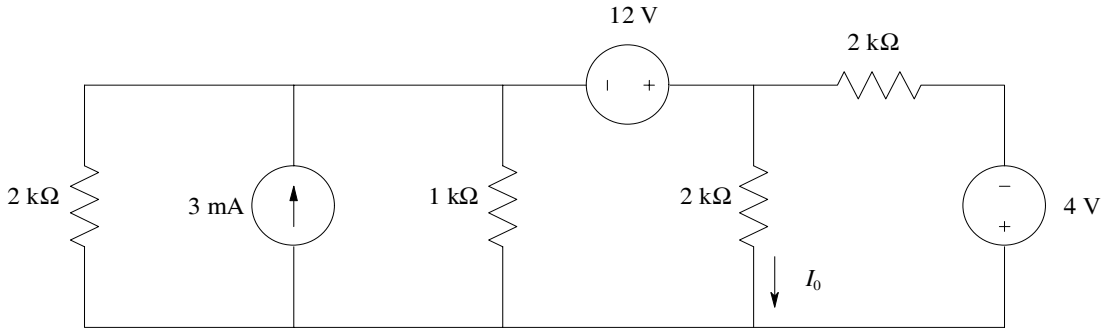
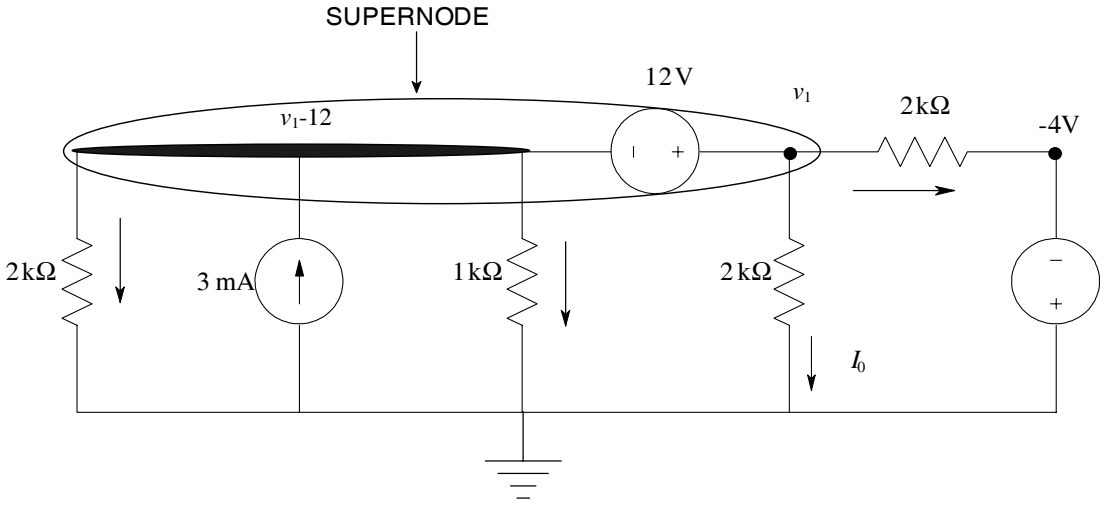


Figure P 2



KCL at the supernode:

$$\frac{v_1-12}{2k}+\frac{v_1-12}{1k}-3m+\frac{v_1}{2k}+\frac{v_1+4}{2k}=0$$

multiply both sides by 2k yields:

$$v_1-12+2v_1-24-6+v_1+v_1+4=0$$

$$5v_1=38$$

$$v_1=\frac{38}{5}=7.6V$$

$$I_0=\frac{v_1}{2k}=3.8mA$$

3. Use mesh analysis to find the power dissipated in the 1Ω resistor in the circuit in Fig.P3.

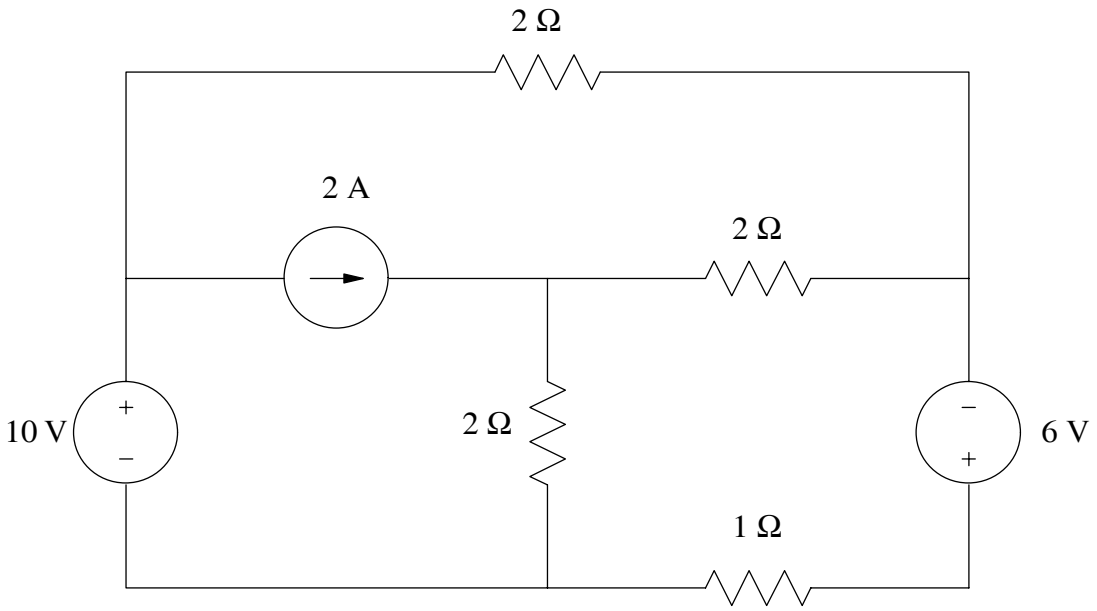
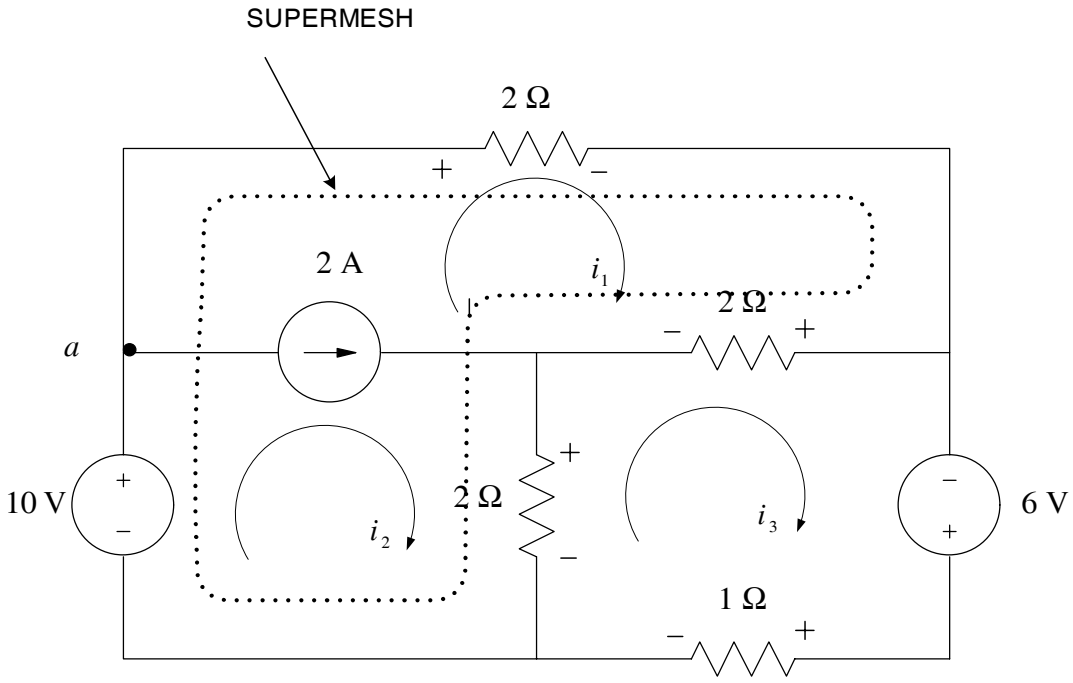


Figure P 3



KVL around the supermesh:

$$-10+2i_1+2(i_1-i_2)+2(i_2-i_3)=0$$

$$4i_1+2i_2-4i_3=10.....(1)$$

KVL around i_3:

$$-2(i_2 - i_3) - 2(i_1 - i_3) - 6 + 1i_3 = 0$$
$$-2i_1 - 2i_2 + 5i_3 = 6 \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

KCL at node *a:*

$$-i_2 + i_1 + 2 = 0$$
$$or$$
$$i_2 = i_1 + 2 \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Subst. of Eq.(3) into (1) and (2) and solving for i_3 yields:

$$i_3 = 6A$$
$$\therefore P_{1\Omega} = (i_3)^2 1 = 36W$$

4. Find the value of I_0 in the circuit in Fig. P4 using

a) Superposition

b) Source transformation

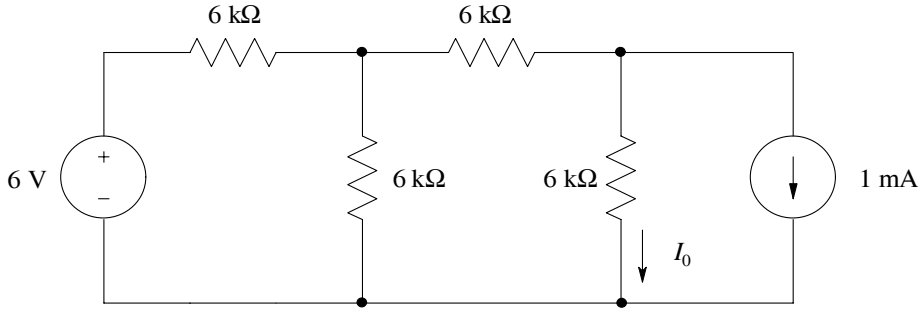
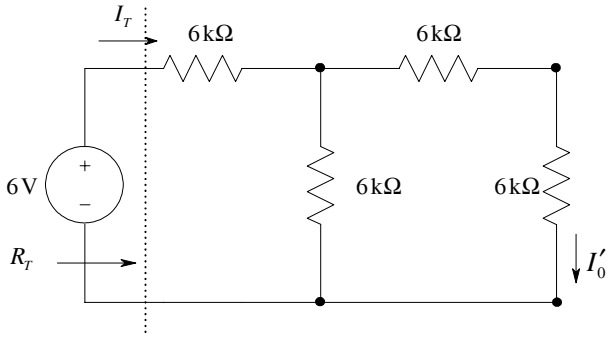


Figure P 4

a) **Superposition**

6 V voltage source is active:

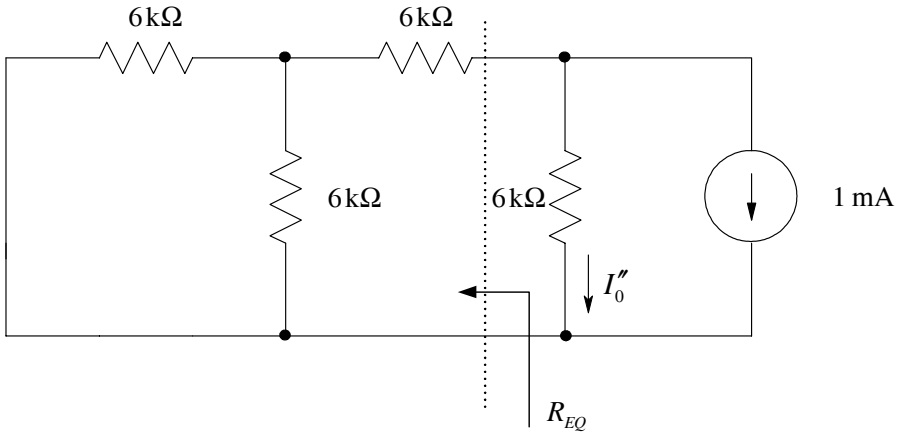


$$R_T = 6k + 6k \,//\, (6k + 6k) = 10k\Omega$$

$$I_T = \frac{6}{10k} = 0.6mA$$

$$I_0' = 0.6\times10^{-3}\,\frac{6k}{6k+12k} = 0.2mA$$

1 mA current source is active:

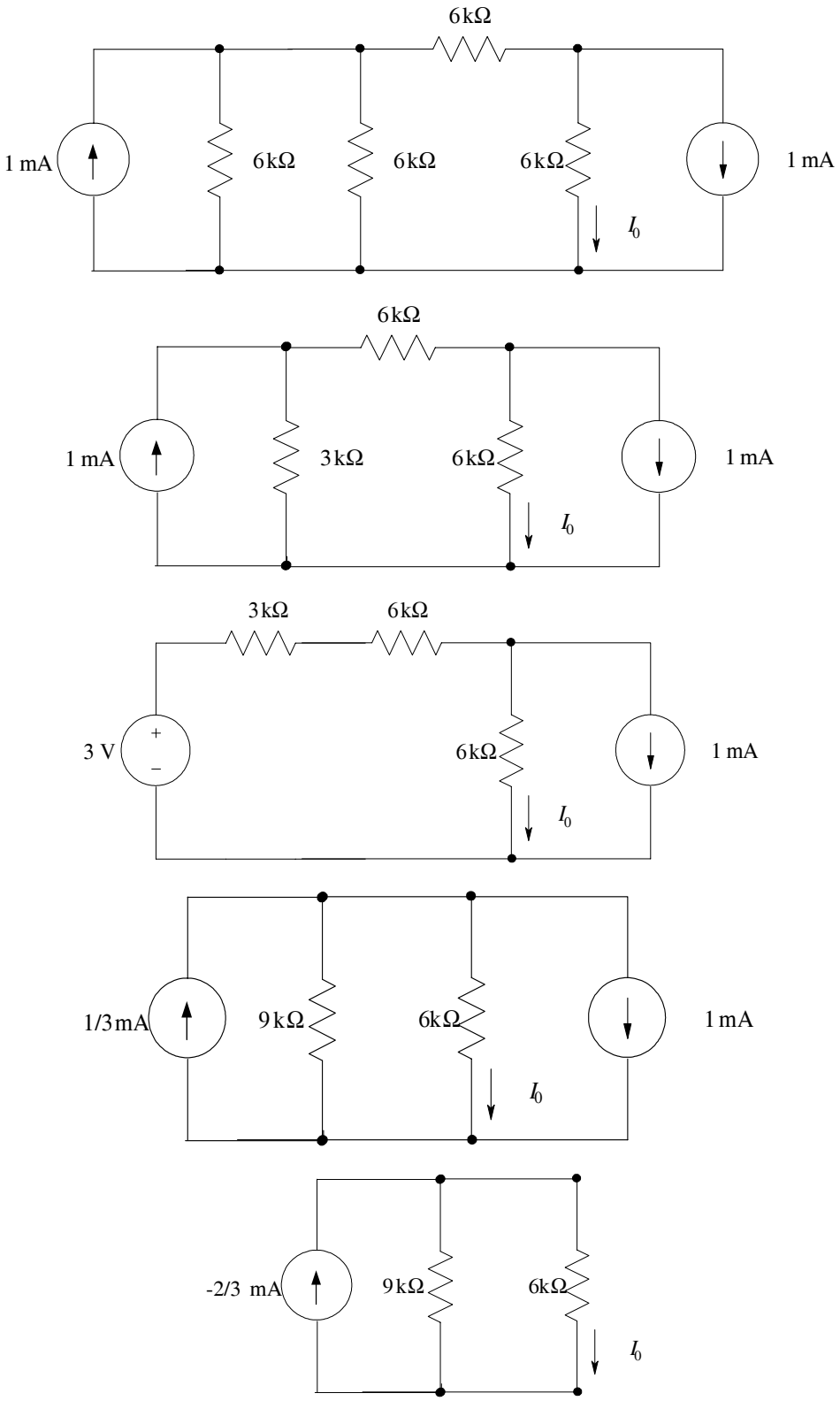


$$R_{EQ} = 6k + 6k \,//\, 6k = 9k\Omega$$

$$I_0'' = -1\times10^{-3}\,\frac{R_{EQ}}{R_{EQ}+6k} = --1\times10^{-3}\,\frac{9k}{15k} = -0.6mA$$

$$\therefore I_0 = I_0' + I_0'' = 0.2m - 0.6m = -0.4mA$$

B) **Source transformation**



$$I_0 = -\frac{2}{3}\times 10^{-3}\,\frac{9k}{9k+6k} = -0.4mA$$