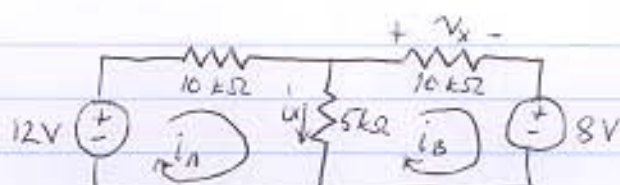


Homework IV

Ch. 3: 9, 11, 12, 18, 27, 30

Ch. 4: 4, 10, 12, 14

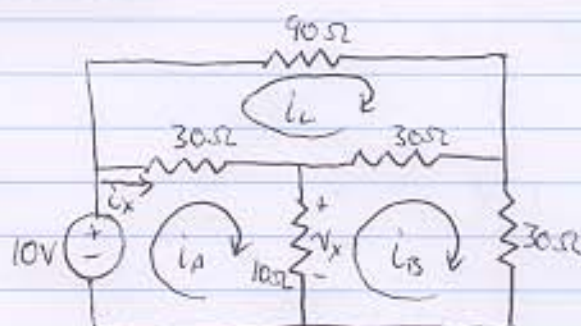
- P.3.9 a) formulate mesh-current eqns
b) find i_x & v_x



a) loop A $-12 + v_{10} + v_5 = 0$
 $-12 + 10i_A + 5(i_A - i_B) = 0$
 ① $15i_A - 5i_B = 12$
 loop B $v_5 + v_x + 8 = 0$
 $5(i_B - i_A) + 10i_B + 8 = 0$
 ② $-5i_A + 15i_B = -8$
 $i_A = \frac{7}{10} \text{ mA}$ $i_B = -\frac{3}{10} \text{ mA}$

b) $i_x = i_A - i_B$ $v_x = (10 \text{ k}\Omega) i_B$
 $i_x = 1 \text{ mA}$ $v_x = -3 \text{ V}$

- P.3.11 a) formulate mesh-current eqns
b) find v_x & i_x



a)
$$\begin{bmatrix} 40 & -10 & -30 \\ -10 & 70 & -30 \\ -30 & -30 & 150 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}$$

$i_A = \frac{1}{3} \text{ A}$

$i_B = \frac{1}{12} \text{ A}$

$i_C = \frac{1}{12} \text{ A}$

$i_x = i_A - i_C$

$i_x = \frac{1}{4} \text{ A} = 0.25 \text{ A}$

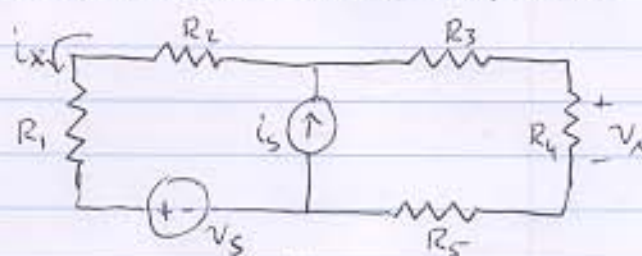
$v_x = 10(i_A - i_C)$

$v_x = \frac{5}{2} \text{ V} = 2.5 \text{ V}$

P. 3.12 a) formulate mesh-current eqns

b) find i_x & v_x when $R_1=200\Omega$, $R_2=300\Omega$, $R_3=50\Omega$, $R_4=250\Omega$, $R_5=200\Omega$, $i_s=50\text{mA}$, $v_s=15\text{V}$

c) find the total power dissipated



$$a) \begin{bmatrix} R_1+R_2+R_3+R_4+R_5 & -R_3-R_4-R_5 \\ -R_3-R_4-R_5 & R_3+R_4+R_5 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \end{bmatrix} = \begin{bmatrix} -v_s \\ +v_s \end{bmatrix}$$

$$i_B = i_s$$

$$b) i_x = i_A = \frac{1}{1000} (500 i_s - v_s)$$

$$i_x = 10\text{mA}$$

$$v_x = R_4 (i_B - i_A)$$

$$v_x = 10\text{V}$$

$$c) P = (R_1+R_2) i_A^2 + (R_3+R_4+R_5) (i_B - i_A)^2 + v_s i_A$$

$$P = 1\text{W}$$

current flows in opposing direction to voltage source.

P. 3.18 all resistors $1\text{k}\Omega$, $v_A=8\text{V}$ when C is grounded. Find v_B , v_D &

mesh-currents i_A & i_B

$$v_A = 8\text{V}$$

$$v_A - v_D = 10\text{V}$$

$$\Rightarrow v_D = -2\text{V}$$

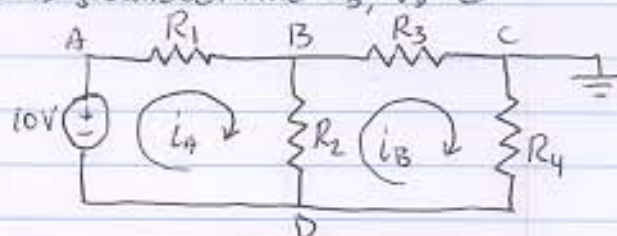
$$\begin{bmatrix} 2 & -1 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}$$

$$i_A = 6\text{mA}$$

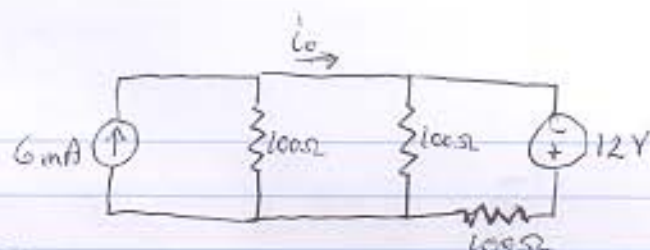
$$i_B = 2\text{mA}$$

$$v_B = R_3 i_B$$

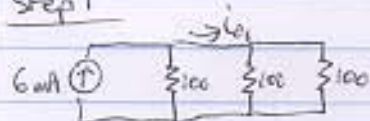
$$v_B = 2\text{V}$$



P.3.27 Use superposition to find i_o

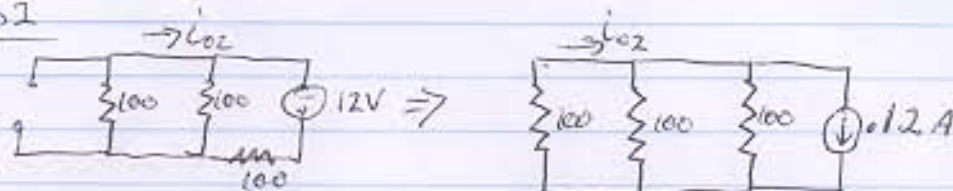


Step 1



$$i_{o1} = \frac{100\Omega}{100\Omega + 50\Omega} 6mA = 4mA$$

Step 2



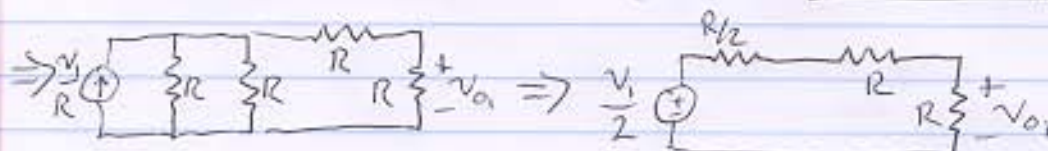
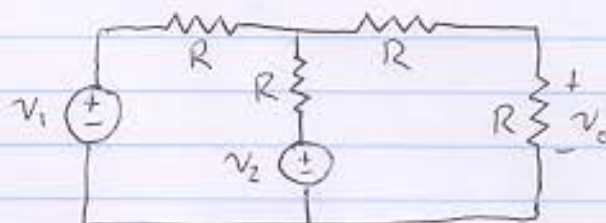
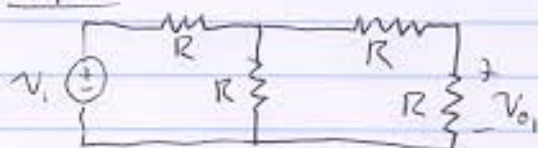
$$i_{o2} = \frac{1}{3} (0.12A) = 0.04A$$

$$i_o = i_{o1} + i_{o2}$$

$$i_o = 4.4mA$$

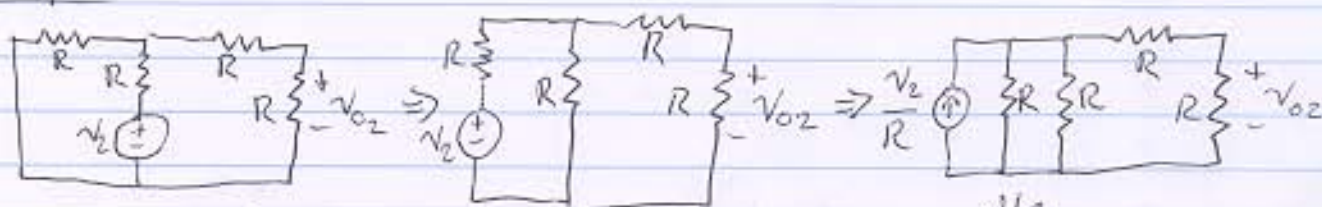
P.3.30 Use superposition to find v_o in terms of v_1 , v_2 & R

Step 1

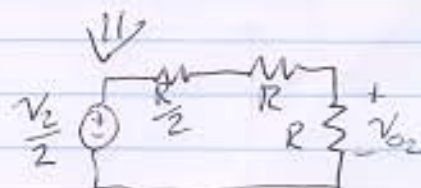


$$v_{o1} = \frac{R}{R+R+R/2} \left(\frac{v_1}{2} \right) = \frac{1}{5} v_1$$

Step 2



$$v_{o2} = \frac{R}{5/2 R} \frac{v_2}{2} = \frac{1}{5} v_2$$



$$v_o = v_{o1} + v_{o2}$$

$$v_o = \frac{1}{5} (v_1 + v_2)$$

P.4.4 Find gains v_o/v_s and i_o/i_x

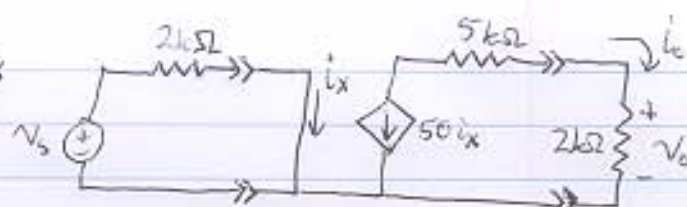
$$i_x = \frac{v_s}{2k\Omega}$$

$$v_o = -(50i_x)(2k\Omega) = -50v_s$$

$$i_o = -50i_x$$

$$\boxed{\frac{v_o}{v_s} = -50}$$

$$\boxed{\frac{i_o}{i_x} = -50}$$



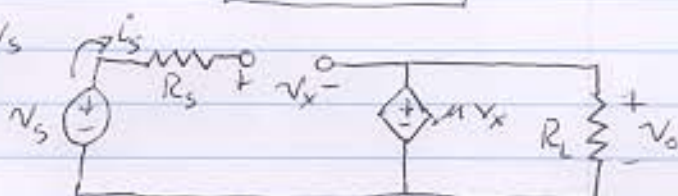
P.4.10 Find expression for v_o/v_s

$$v_x = v_s - \mu v_x$$

$$v_o = \mu v_x$$

$$v_o = \mu \left(\frac{v_s}{1+\mu} \right)$$

$$\boxed{\frac{v_o}{v_s} = \frac{\mu}{1+\mu}}$$

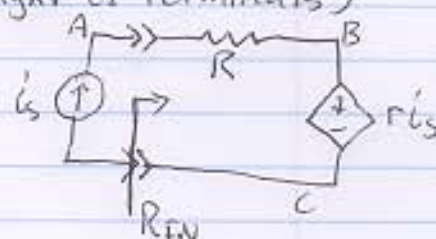


P.4.12 Find R_{IN} (equivalent resistance to right of terminals)

$$R_{IN} = \frac{v_A}{i_s}$$

$$v_A = i_s R + r i_s$$

$$R_{IN} = \frac{i_s R + i_s r}{i_s} = \boxed{R + r}$$



P.4.14 Find Thévenin equivalent circuit seen by the load

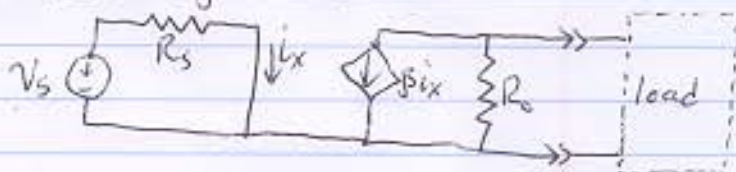
Step 1 - voltage unloaded



$$v_{oc} = -R_o \beta i_x$$

$$i_x = v_s / R_s$$

$$v_T = v_{oc} = -\frac{R_o \beta v_s}{R_s}$$



Step 2 - find i through short circuit



$$i_N = -\beta i_x$$

$$i_x = v_s / R_s$$

$$i_N = -\frac{\beta v_s}{R_s}$$

$$R_T = \frac{v_T}{i_N} = R_o$$

