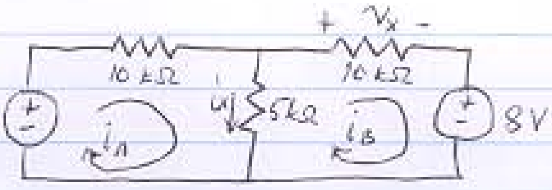
Homework IV   Ch. 3: 9, 11, 12, 18, 27, 30
Ch. 4: 4, 10, 12, 14

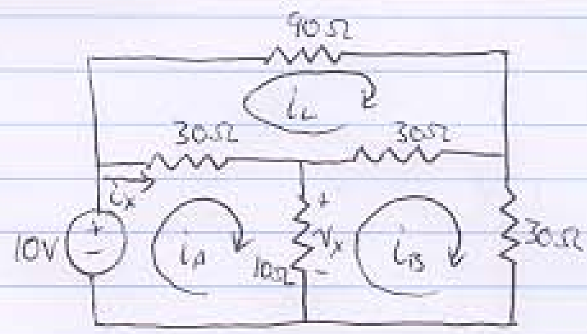
P.3.9 a) formulate mesh-current eqns
b) find i_x & v_x



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 $$-5i_A + 15i_B = -8$$
$i_A = \frac{7}{10}$ mA $i_B = -\frac{3}{10}$ mA

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

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



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

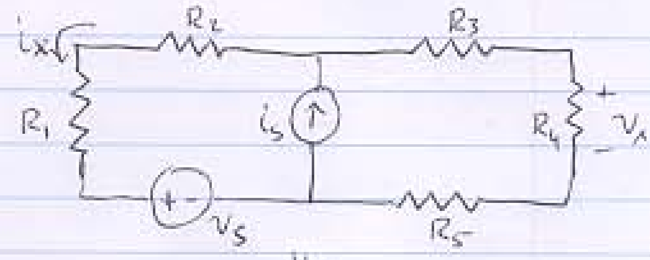
$i_A = \frac{1}{3}$ A
$i_B = \frac{1}{12}$ A
$i_C = \frac{1}{12}$ A

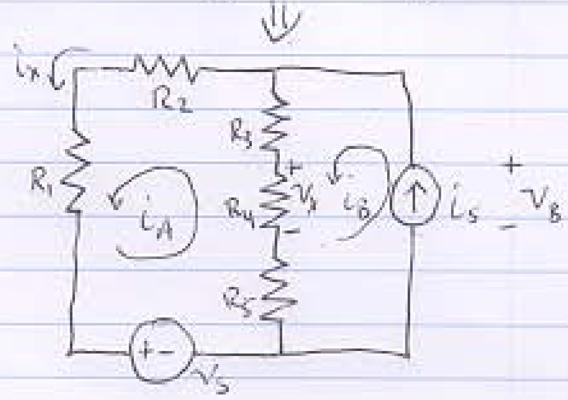
$i_x = i_A - i_C$
$\boxed{i_x = \frac{1}{4}\text{ A} = 0.25\text{ A}}$
$v_x = 10(i_A - i_B)$
$\boxed{v_x = \frac{5}{2}\text{ V} = 2.5\text{ V}}$

P.3.12 a) formulate mesh-current eqns

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

c) find the total power dissipated





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

$$i_B = i_s$$

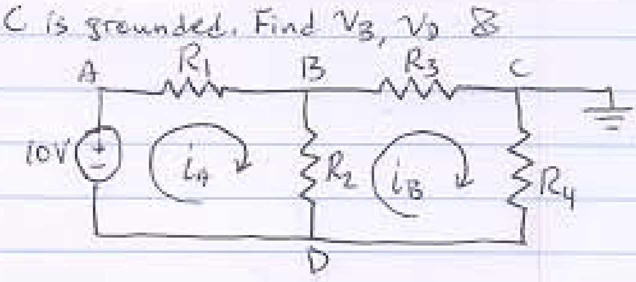
b) $$i_x = i_A$$
$$= \frac{1}{1000}(500 i_s - V_s)$$
$$\boxed{i_x = 10mA}$$

$$V_x = R_4(i_B - i_A)$$
$$\boxed{V_x = 10V}$$

c) $$P = (R_1+R_2)i_A^2 + (R_3+R_4+R_5)(i_B - i_A)^2 + \underbrace{V_s i_A}$$
$$\boxed{P = 1W}$$

current flows in opposing direction to voltage source.

P.3.18 all resistors $1k\Omega$, $V_A = 8V$ when C is grounded. Find V_B, V_D & mesh-currents i_A & i_B



$$V_A = 8V$$
$$V_A - V_D = 10V$$
$$\Rightarrow \boxed{V_D = -2V}$$

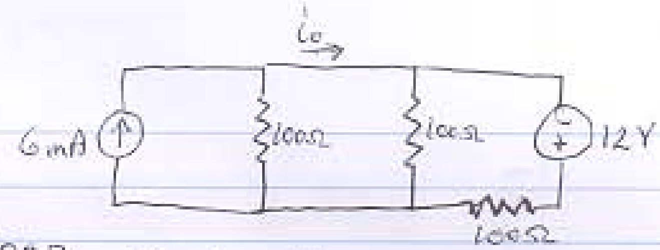
$$\begin{bmatrix} 2 & -1 \\ -1 & 3 \end{bmatrix}\begin{bmatrix} i_A \\ i_B \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}$$

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

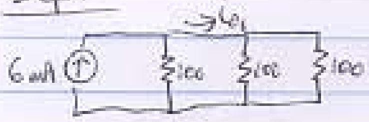
$$\boxed{i_B = 2\ mA}$$

$$V_B = R_3 i_B$$
$$\boxed{V_B = 2V}$$

P.3.27 Use superposition to find i_o

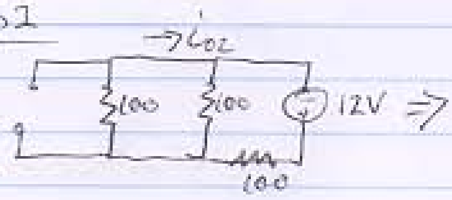


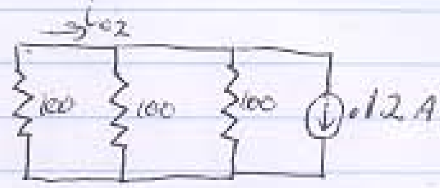
Step 1



$$i_{o_1} = \frac{100\Omega}{100\Omega + 50\Omega} 6mA = 4mA$$

Step 2



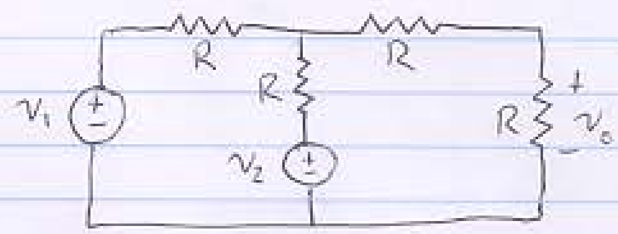


$$i_{o2} = \frac{1}{3}(0.12A) = 0.04A$$

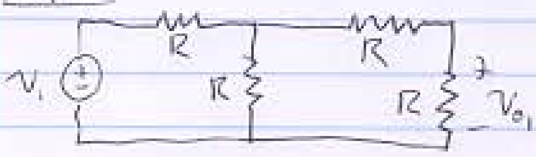
$i_o = i_{o1} + i_{o2}$

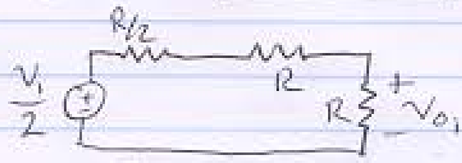
$\boxed{i_o = 44mA}$

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



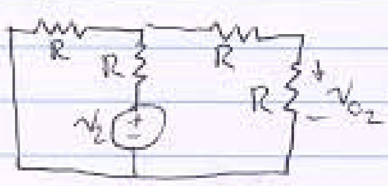
Step 1

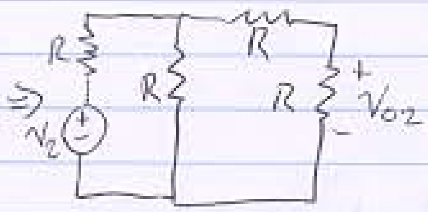


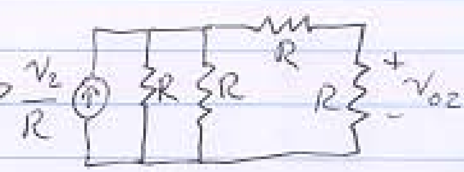


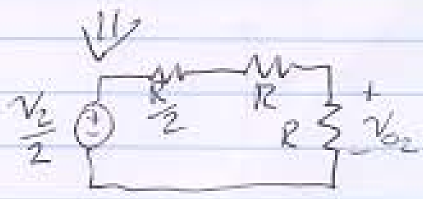
$$v_{o1} = \frac{R}{R+R+R/2}\left(\frac{v_1}{2}\right) = \frac{1}{5} v_1$$

Step 2







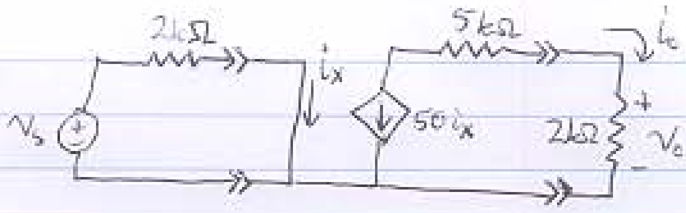


$$v_{o2} = \frac{R}{\frac{5}{2}R} \frac{v_2}{2} = \frac{1}{5} v_2$$

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

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

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



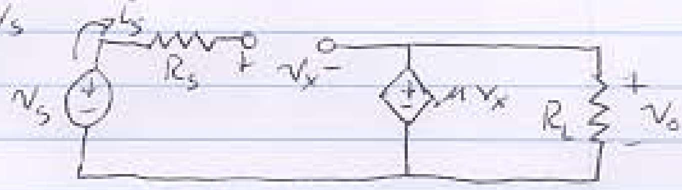
$$i_x = \frac{v_s}{2k\Omega}$$

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

$$i_o = -50i_x$$

$$\boxed{\frac{v_o}{v_s} = -50} \qquad \boxed{\frac{i_o}{i_x} = -50}$$

P.4.10 find expression for v_o/v_s



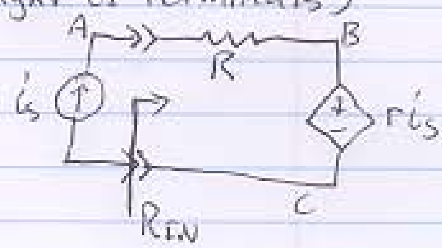
$$v_x = v_s - \mu v_x$$

$$v_o = \mu v_x$$

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

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

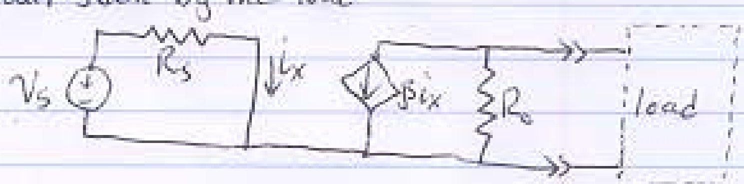
P.4.12 Find R_{IN} (equivalent resistance to right of terminals)



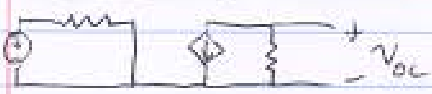
$$R_{IN} = \frac{v_A}{i_s} \qquad v_A = i_s R + r i_s$$

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

P.4.14 Find Thévenin equivalent circuit seen by the load



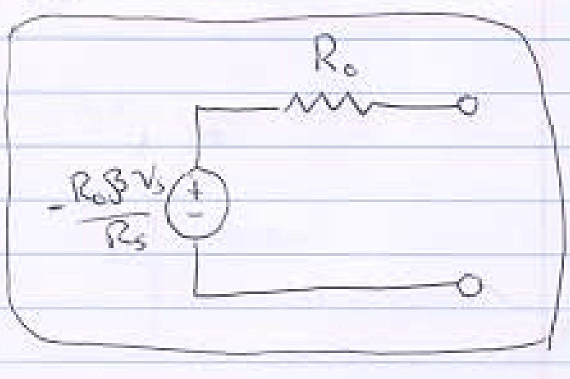
Step 1 - Voltage unloaded



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

$$i_x = v_s/R_s$$

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



Step 2 - find i through short circuit

$$i_N = -\beta i_x$$

$$i_x = v_s/R_s \qquad i_N = -\frac{\beta v_s}{R_s}$$

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