ECE 2300, Exam #2, Nov. 17th, 2012

PROBLEM 2 EXAM 2
FALL 2012

Problem 2 (30 points):
For the circuit shown in Figure 2, do the following.

a) Find the Norton equivalent as seen by R_x
b) Draw the Norton equivalent and label it, showing how it is connected to R_x.
c) If the power absorbed by R_x is 2[mW], find the value of R_x.

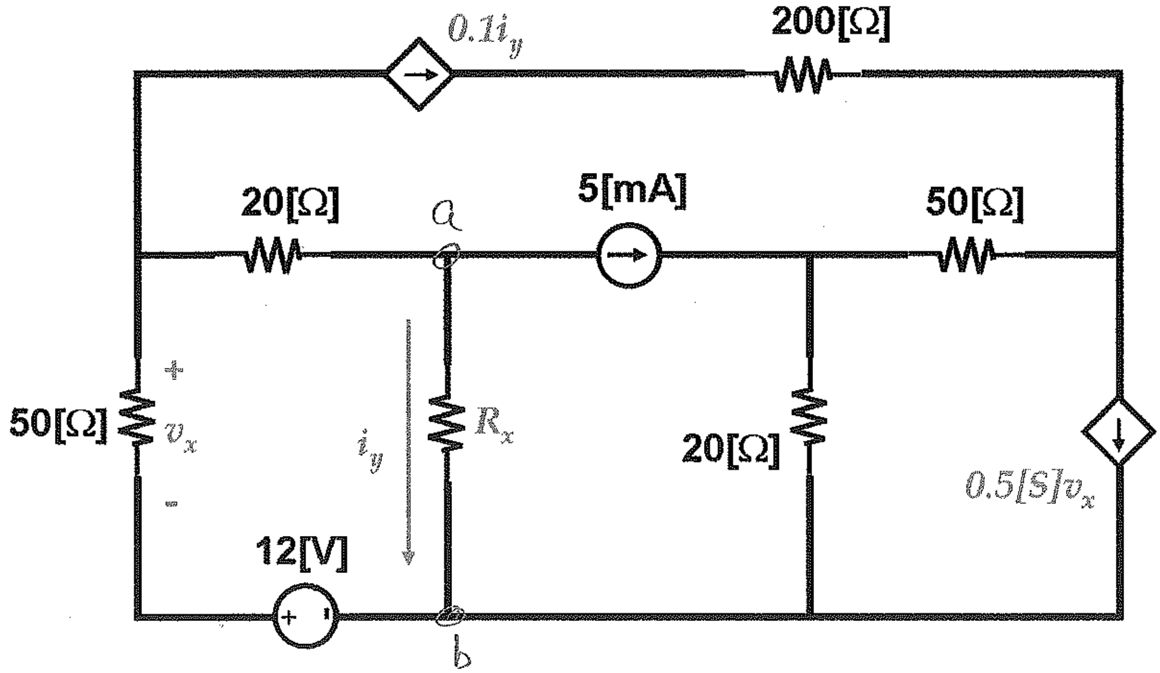
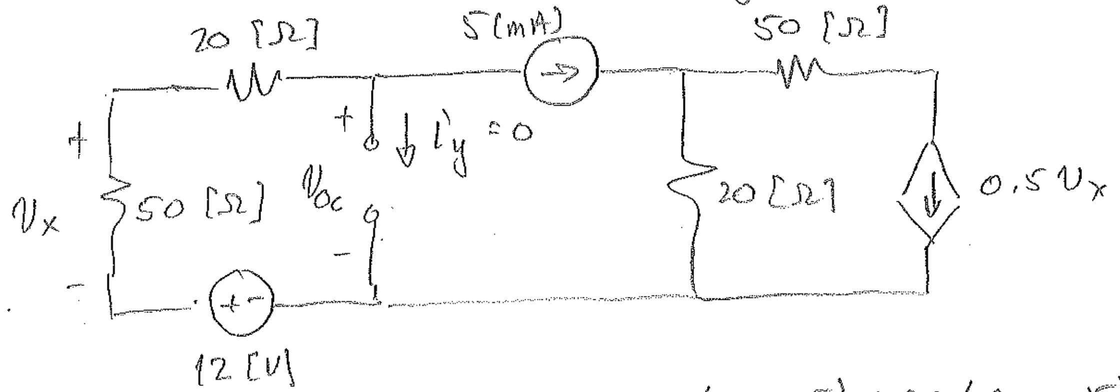


Figure 2

To properly indicate how the equivalent circuit is connected to R_x, we need to indicate a polarity. In this case we have done this by labelling terminals a, b. This is required for full credit in part b).

We need to choose two of : (i) open circuit voltage, (ii) short circuit current and (iii) test source to get R_N. We will do all three here, but only two were required.

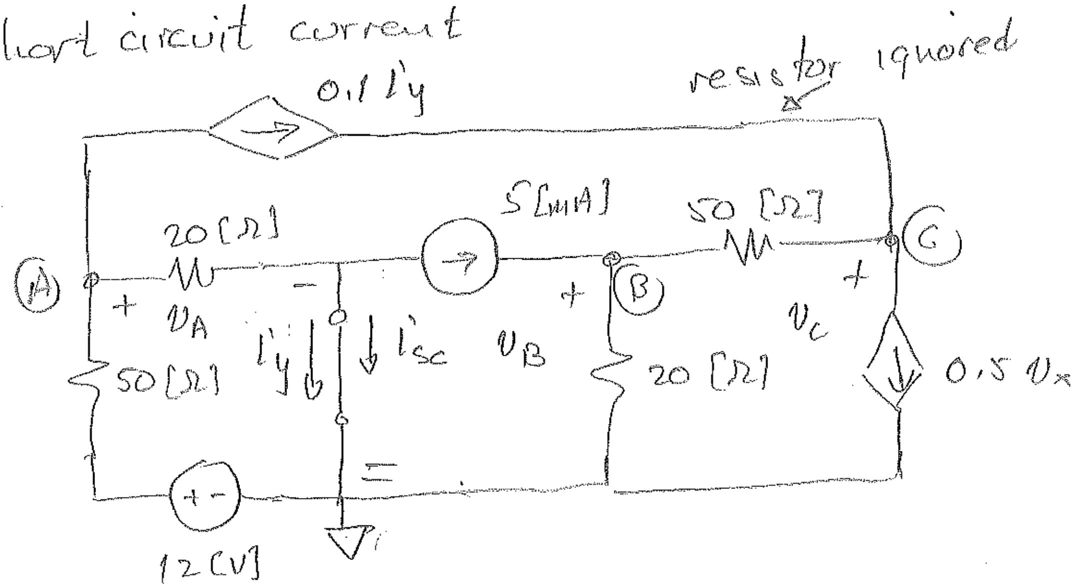
(i) open-circuit voltage $\Rightarrow$ $i'_y = 0$, so...



$$v_{oc} - 12 + 50(0.005) + 20(0.005) = 0$$

$$\boxed{v_{oc} = 11.65\ [V]}$$

(ii) short circuit current



(A) $\dfrac{v_A - 12}{50} + \dfrac{v_A}{20} + 0.1\,i'_y = 0$

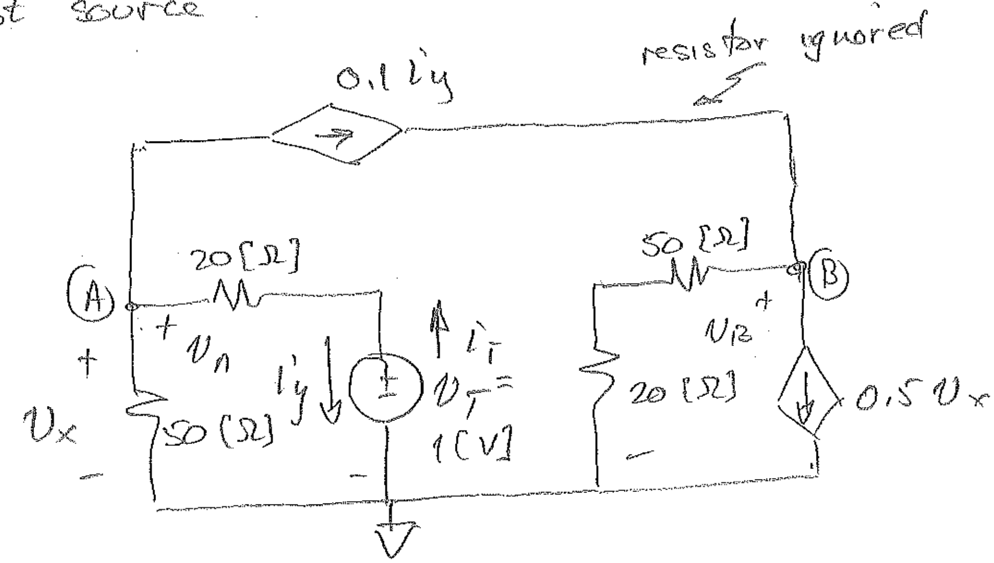
(B) $\dfrac{v_B}{20} - 0.005 + \dfrac{v_B - v_C}{50} = 0$ (C) $-0.1\,i'_y + 0.5\,v_x + \dfrac{v_C - v_B}{50} = 0$

$v_x = v_A - 12$ $\quad i'_y = \dfrac{v_A}{20} - 0.005$

we have 5 eqns but all we need is $i'_{sc} = i'_y$, so we only have to solve (A): $v_A = 3.207$ [V]

$$\boxed{i'_{sc} = \frac{v_A}{20} - 0.005 = 155.3\ [mA]}$$

(iii) test source



(A) $\dfrac{v_A}{50} + \dfrac{v_A - 1}{20} + 0.1\, i'_y = 0 \qquad i'_y = -i'_T$

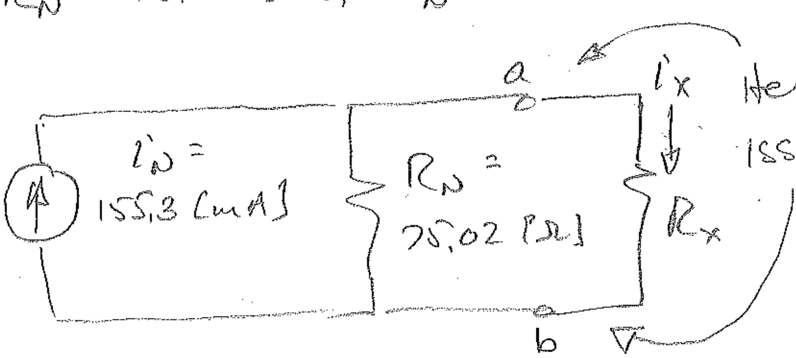
(B) $\dfrac{v_B}{70} + 0.5 v_x - 0.1\, i'_y = 0 \qquad i'_T = \dfrac{1 - v_A}{20}$

$v_A = 0.733$ [V] $\qquad i'_T = 13.33$ [mA]

$\Rightarrow \quad R_N = \dfrac{1}{i'_T} = 75.02$ [Ω] $-$or$-$ $R_N = \dfrac{v_{oc}}{i'_{sc}} = \dfrac{11.65}{0.1553} = 75.02$ [Ω]

a) So $R_N = 75.02$ [Ω], $i'_N = 155.3$ [mA]

b)



Here is the polarity issue we were talking about.

c)

looking at part b, we have

$$i_x = (0.155)\left(\frac{75}{75+R_x}\right)$$

$$i_x^2 R_x = 0.002$$

$$\Rightarrow \boxed{R_x = 83.07 \text{ m}\Omega \quad \text{or} \quad R_x = 67.74 \text{ k}\Omega}$$