# Lecture 15 - Q/A session for MT1

Administrivia
- → cheating on HWs (HW #6 & others)
  - → will be resolved after midterm 1
- → website/email was down over the weekend
  - → now back up.
- → MIDTERM THURSDAY, check Exams link (for extra office hours etc.)

Questions: → (1) Transmogrifier

(2) RC circuit example

(3) From practice midterm: Thevenin equivalent problem.

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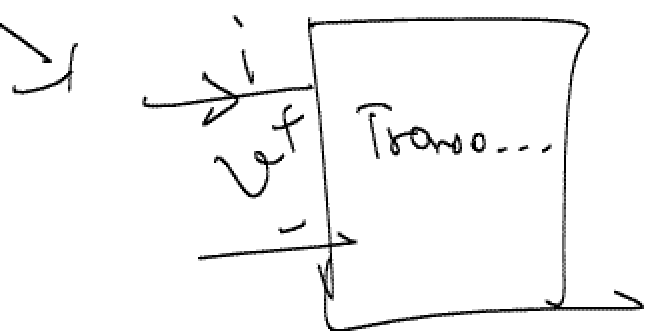
General note: When you see an EE problem, try KCL, KVL, voltage divider etc. because simple methods are "good" i.e.. intuitive etc. And, reinforces the K.I.S.S (Keep it Simple Stupid) principle.

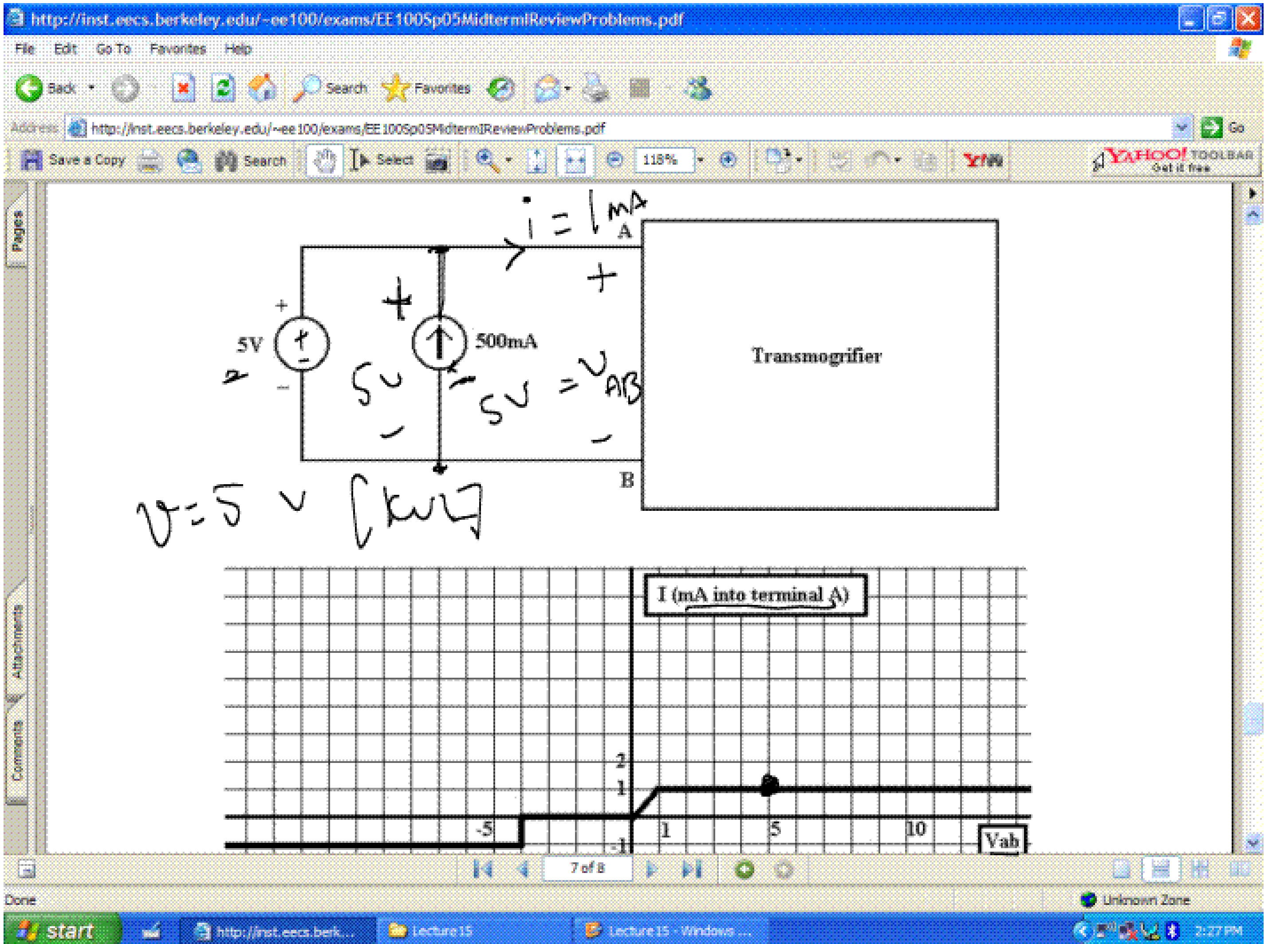
(1) <u>Transmogrifier</u> (from review problem set).

(a) $p = vi$ (<u>note</u>: careful if absorbing or releasing)

convention

We need to find $v$, find an $i$ for the transmogrifier.



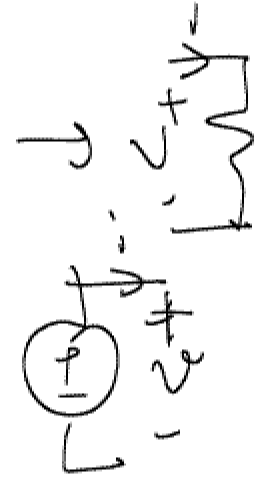



$\therefore\; p = vi = (5V)(1mA) = 5mW$ (absorbing)

= 100 + 5 mW

**Note:** (use) absorbing →

& delivering →

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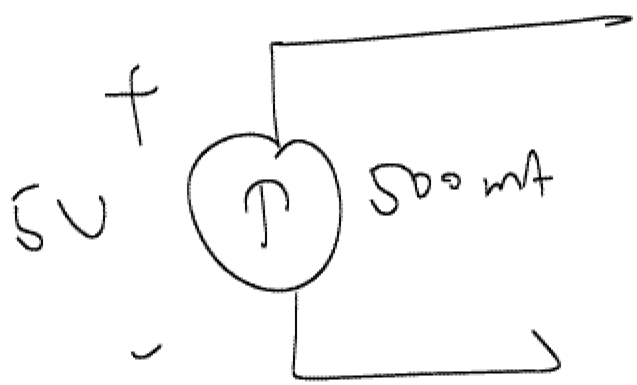
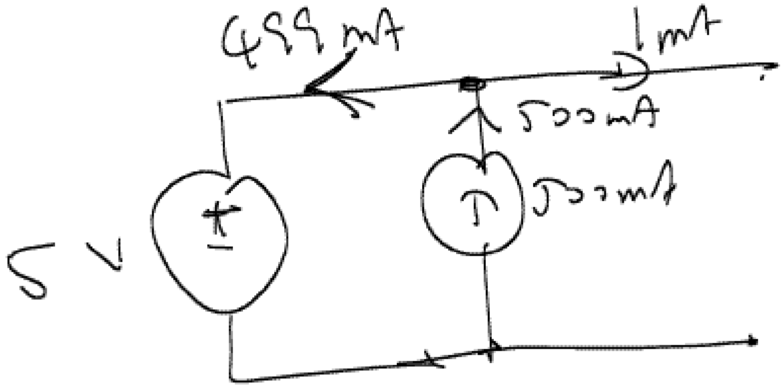
(b)




$P_{delivering} = (5)(500\text{ mA})$

$= 2500$ mW

(or) $P = -2500$ mW




$P_{absorbing} = (5\,V)(499)$

$= 2495\ mW$

(so) $P = +2495\ mW$

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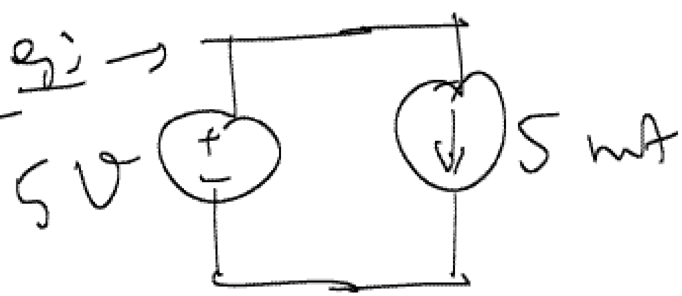
(Q:) Will a current source ever absorb power?

(A:) Yes e.g. →

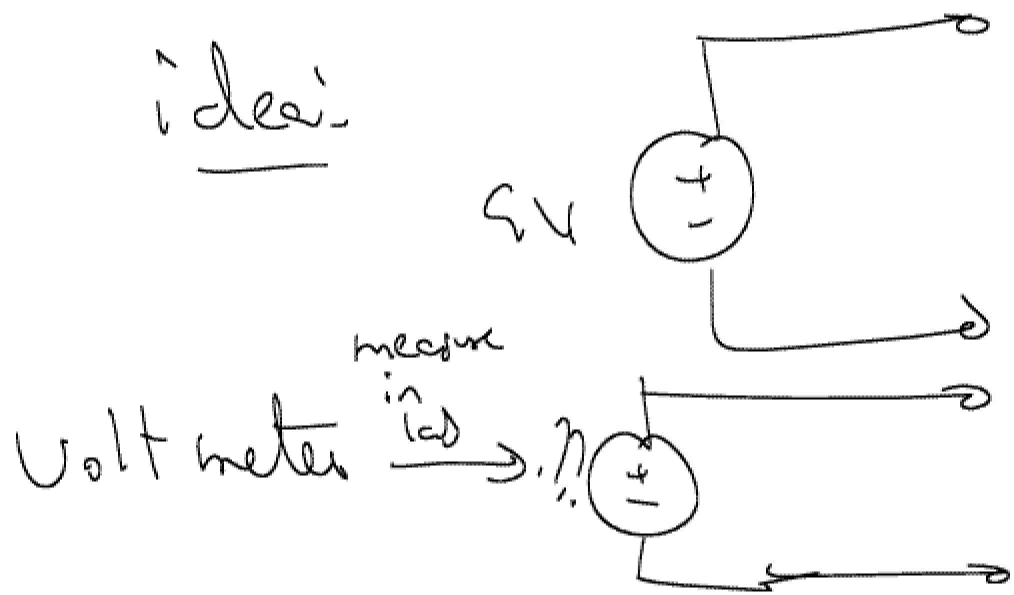


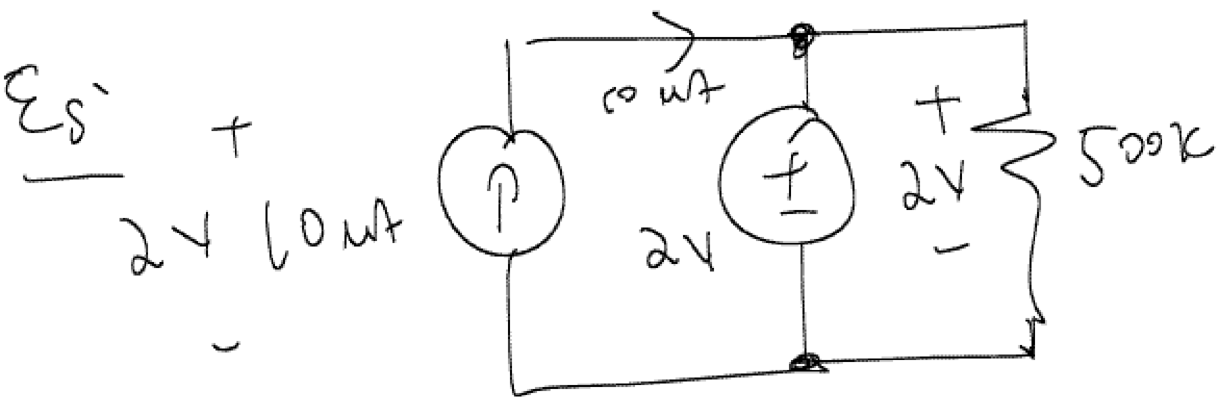
(Q): How ideal are real batteries?

(A:) Measure it yourself:

Experiment: (1) Take a battery e.g. 9V duracell.

ideal:





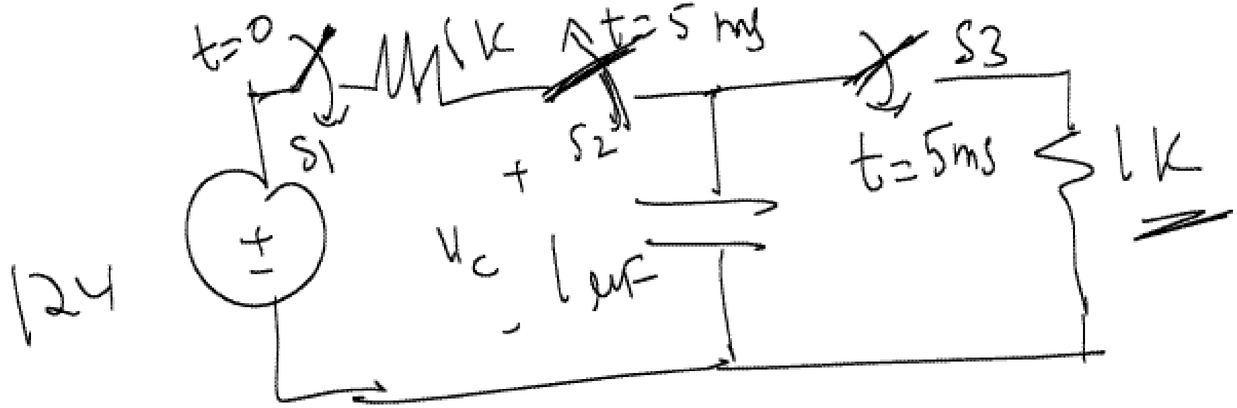

$P_R = \underline{8\ \mu W}$

$$P = vi = v\left(\frac{v}{R}\right) = \frac{v^2}{R} = \frac{4}{500k}$$

$$= 8\ \mu W$$

## RC Circuits

Ex:

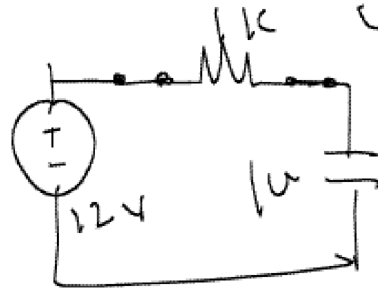



(Q:) Find $v_c$, assume capacitor is initially discharged. Sketch $v_c(t)$.

$$v_c(t) = v_f + (v_i - v_f)e^{-t/\tau}, \quad \tau = RC$$

| $t = 0^-$ | $t = 0^+$ | $t = 5\ ms^-$ | $t = 5\ ms^+$ | $t \to \infty$ |
|---|---|---|---|---|


$v_i = 0$ V



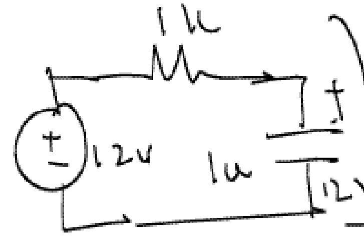

$v_i = 0$ V

$v_f = 12$ V

Note: ignore S3 for this calculation.

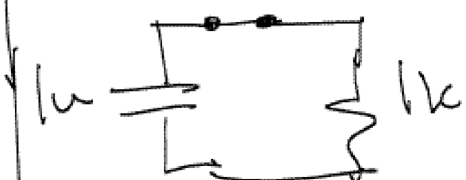
$v_c(t) = 12(1 - e^{-t/\tau})$

$\tau = RC = (1k)(1u) = 1ms$




$v_i = 12$ V

t > 5 ms

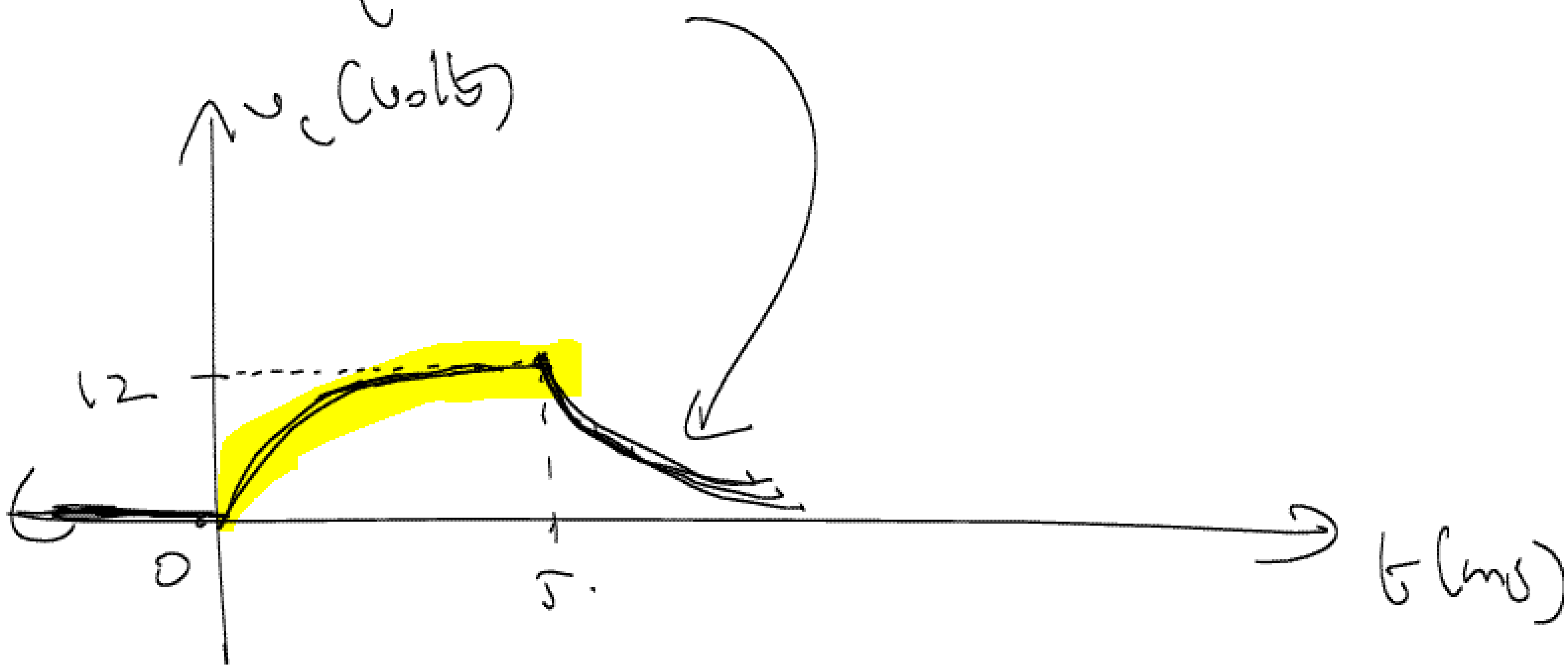



$v_f = 0$ V

$v_c(t) = 12e^{-t/1ms}$

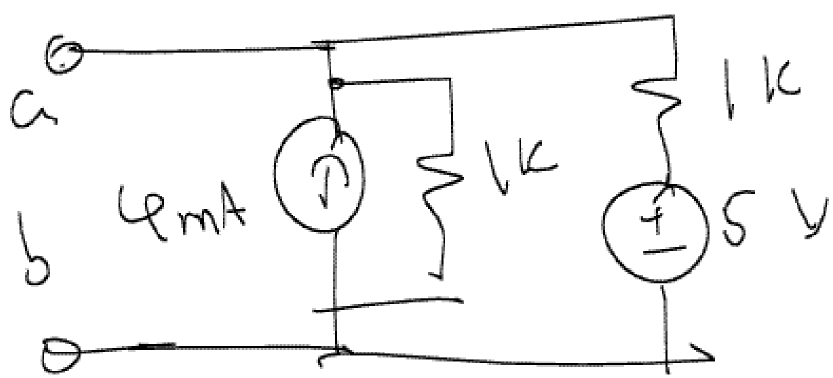
$\tau = 1ms$

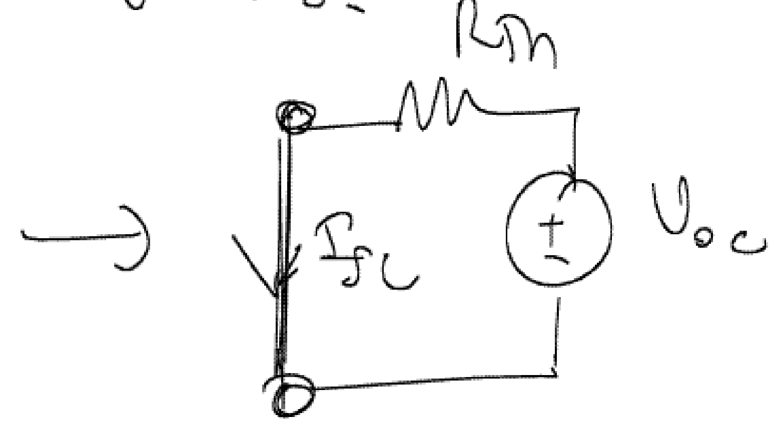
$$v_c(t) = \begin{cases} 0 & \text{if } t \le 0 \\ 12\left(1 - e^{-t/1\,ms}\right) & \text{if } 0 \le t \le 5\,ms \\ 12\, e^{-\frac{(t-5)}{1\,ms}} & \text{if } t \ge 5\,ms \end{cases}$$



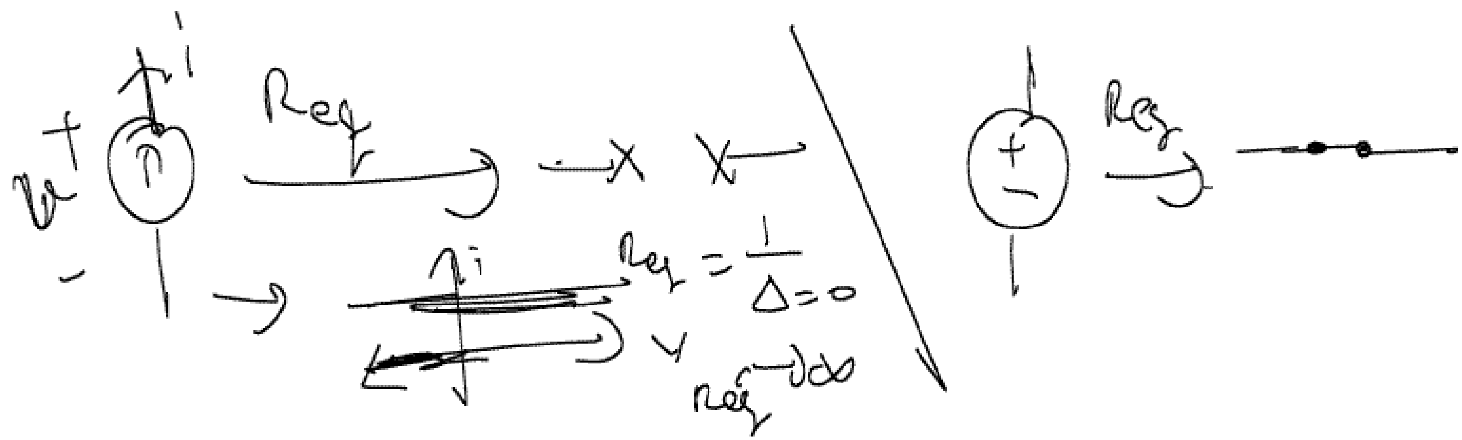
## (3) Thevenin / Norton : Sample problems.

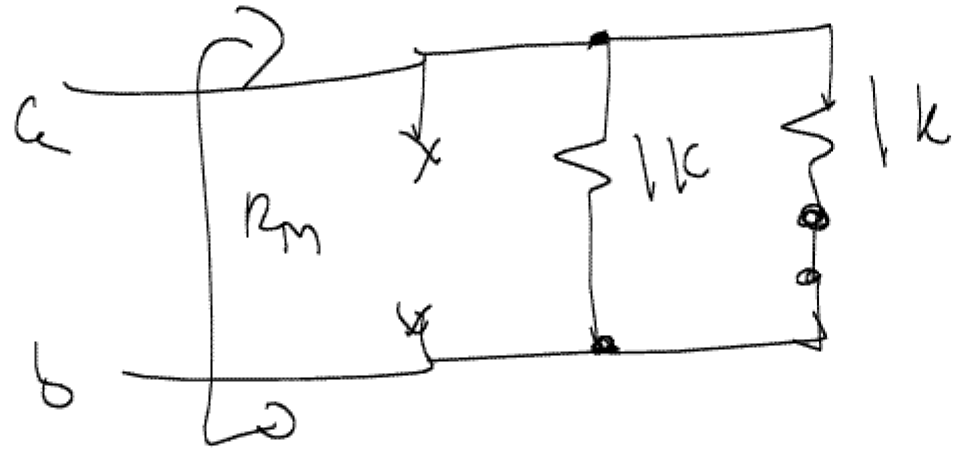
(Q:) Find thevenin equivalent at AB.




$R_{Th}$ :





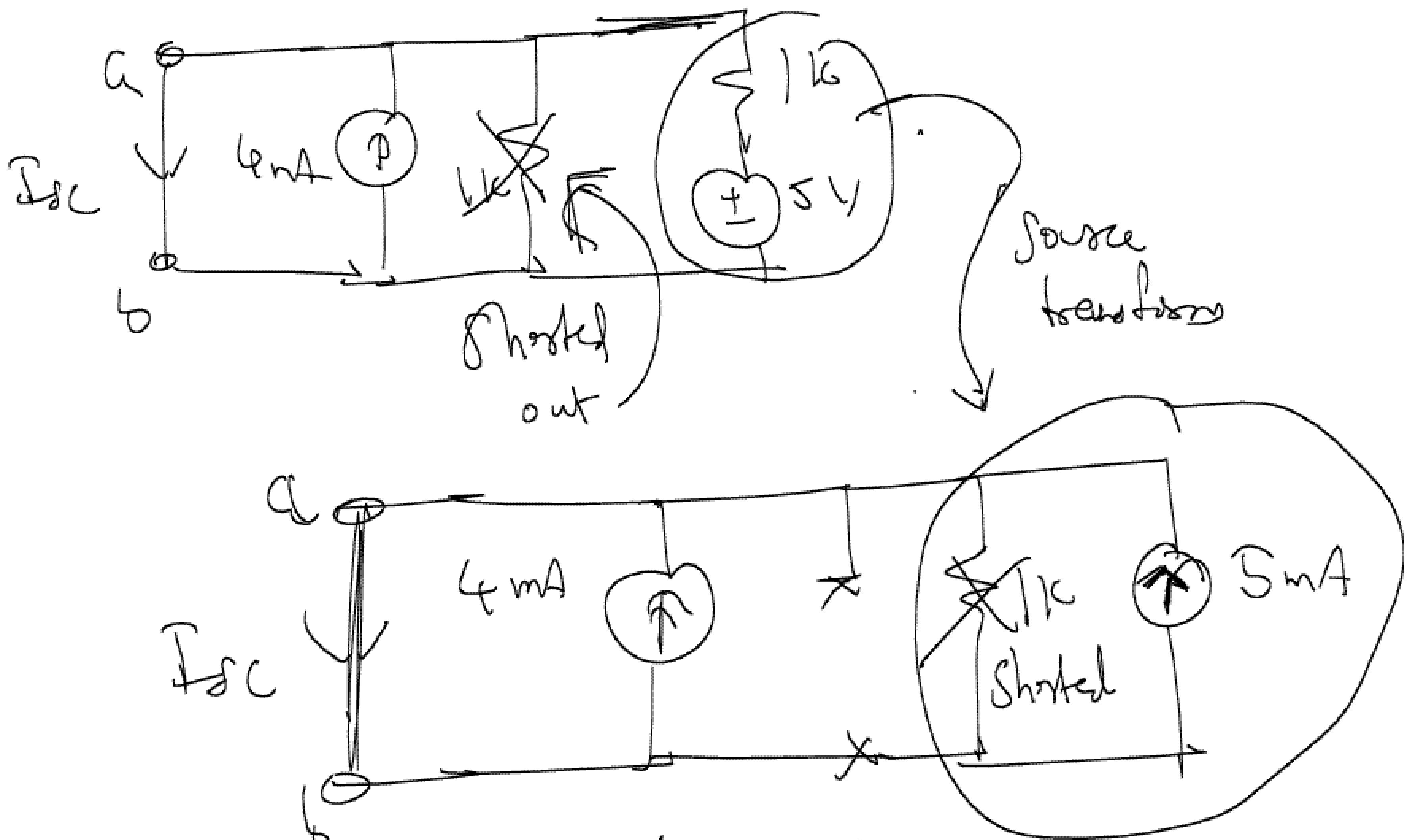

$$R_{Th} = (1k) \parallel (1k)$$

$$= 0.5k$$

$$= 500\,\Omega$$

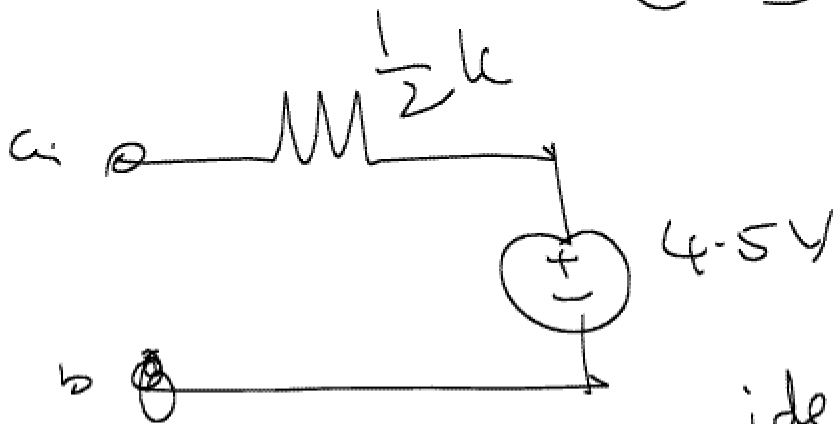
$$V_{oc} = (I_{sc})(R_{Th})$$

$I_{sc}$ is probably easier!



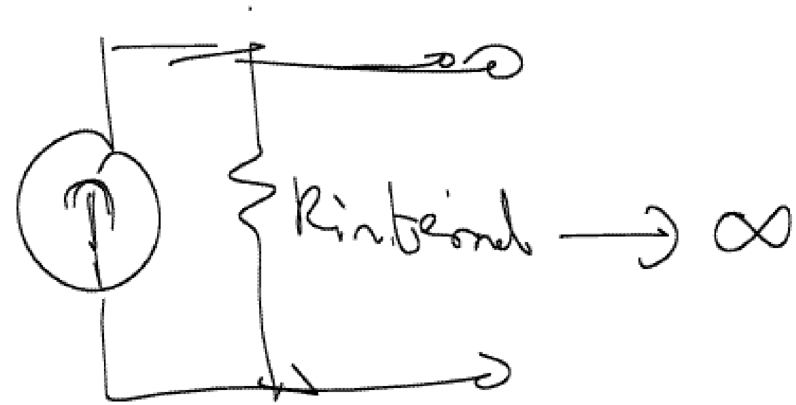

$I_{sc} = 4\,mA + 5\,mA = 9\,mA$

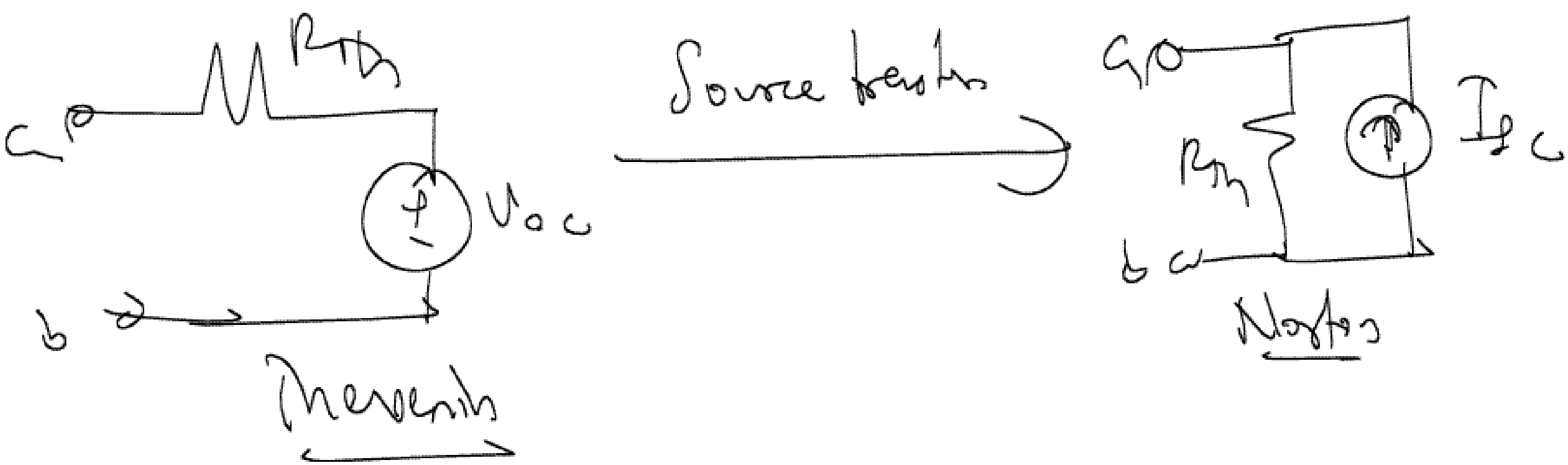
$$V_{oc} = (9\,mA)\cdot\left(\frac{1}{2}k\right) = 4.5\,V$$



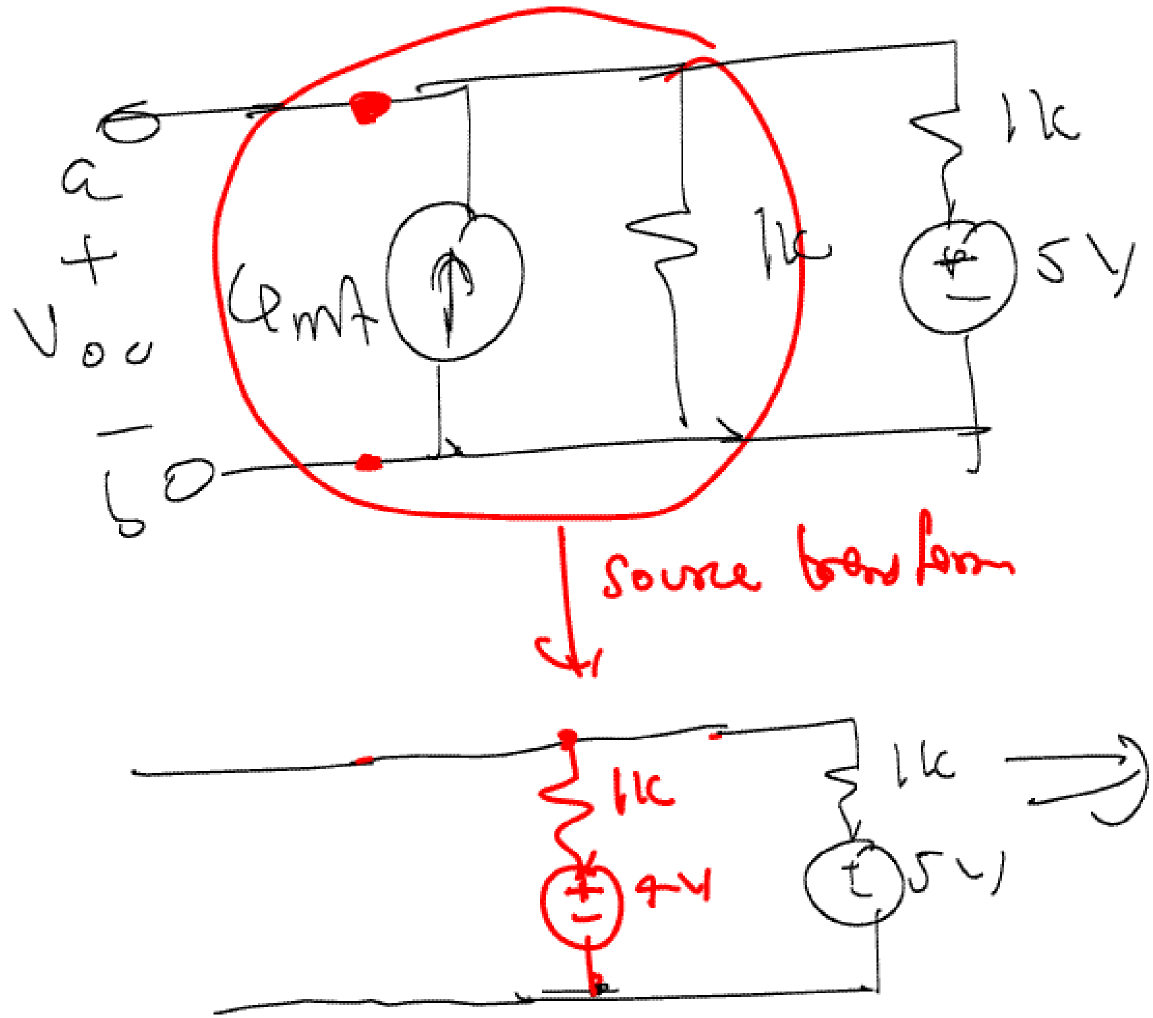

**Note!** (1)

(2)


Rinternal → ∞

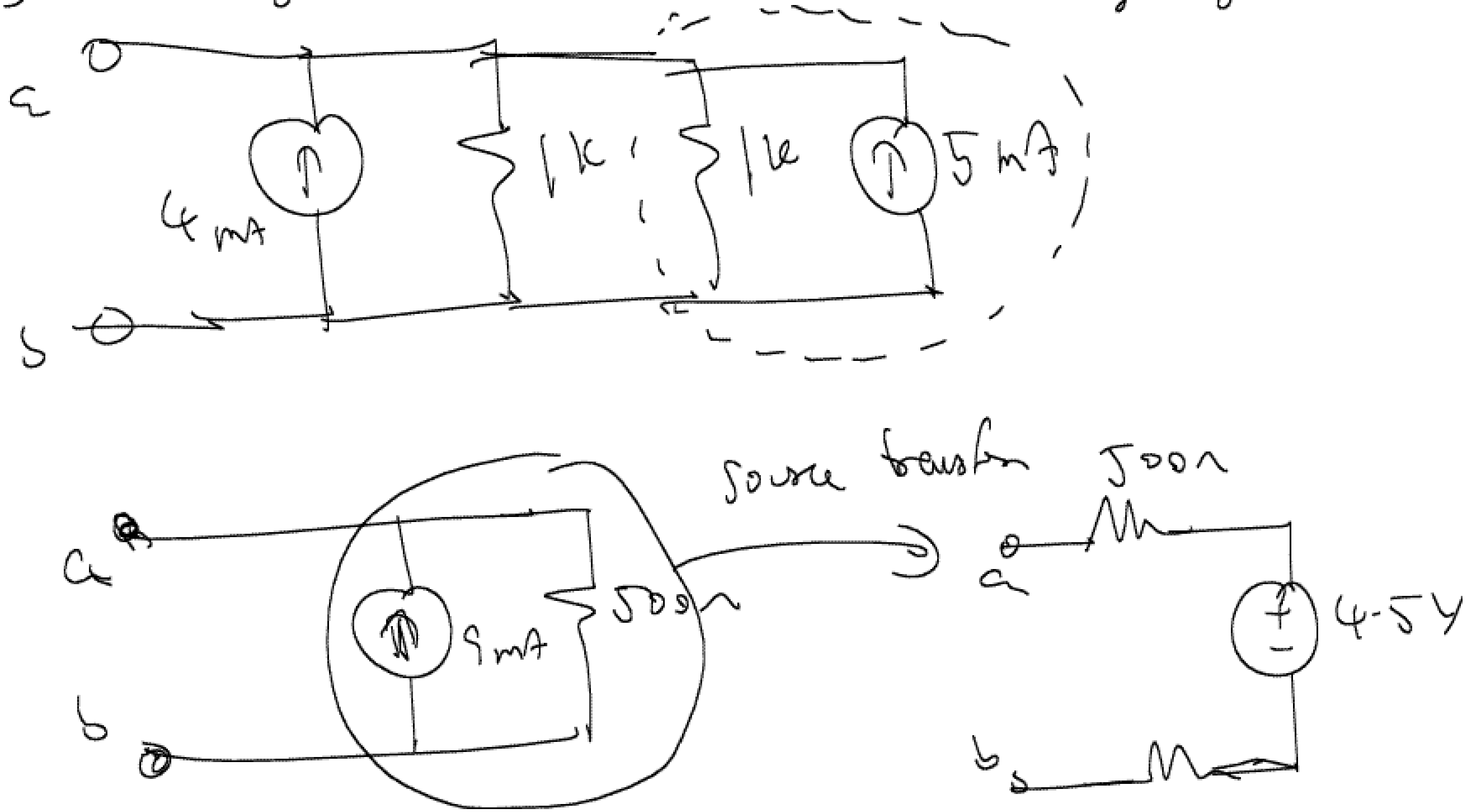

a
b
RTh
Voc
Thevenin
Source transformation
a
b
RTh
Isc
Norton

$V_{oc}$: This may be harder:

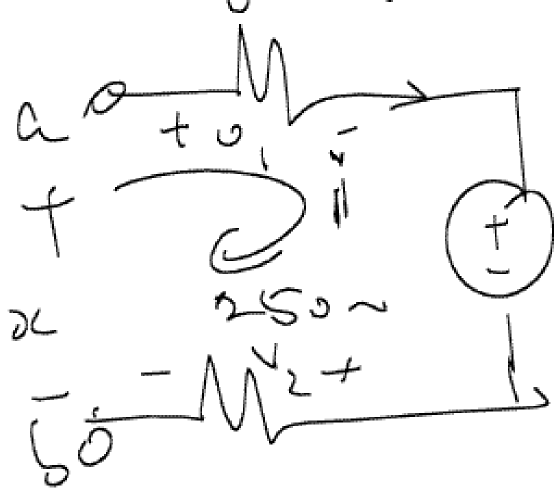



Does not really help

But, if you do it for the voltage source:

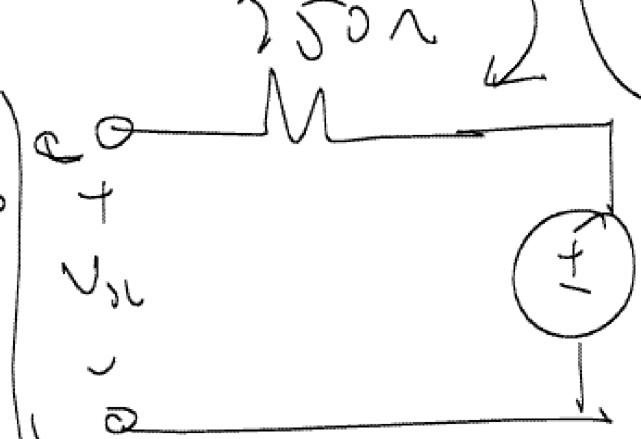


(Qi:) Is




equivalent (?)

Answer: Yes!




KVL: $V_x - v_1 - 4.5 - v_2 = 0$

$\Rightarrow V_x - (i)(500) - 4.5 - i(250) = 0$

$\Rightarrow V_x = 4.5 + i(750)$

Next time: No lecture!

MIDTERM!

(1) Makeup midterm from 2-5 in 299 Cory

(2) midterm, 6 pm - 9 pm in 1 Pimentel

No bluebooks necessary, you may bring a page of notes and a calculator.

P.S.: I will show the end of Spaceballs sometime after spring break!