Noëlie
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61

Physic's IE

13/20 Good Work!

(2/2) **Lecture questions:**

0.5 1) For an ideal coil $\underline{Z} = jL\omega$

0.5 For an indeal capacitor $\underline{Z} = \frac{1}{Cj\omega}$

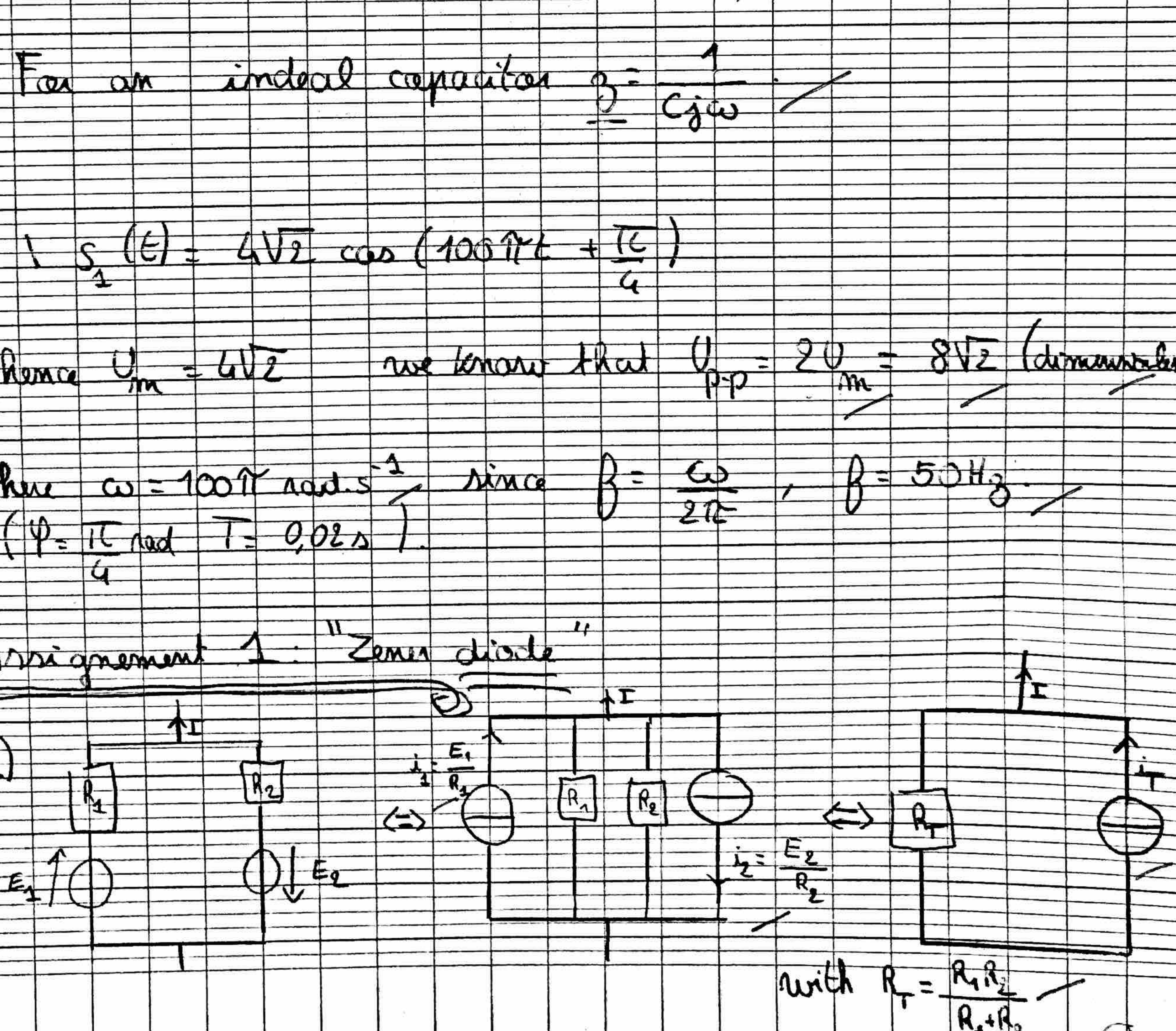
2) $s_1(t) = 4\sqrt{2}\cos(100\pi t + \frac{\pi}{4})$

0.5 Hence $U_m = 4\sqrt{2}$ we know that $U_{p-p} = 2U_m = 8\sqrt{2}$ (dimensionless)

0.5 here $\omega = 100\pi\ rad.s^{-1}$ since $f = \frac{\omega}{2\pi}$, $f = 50\ Hz$
($\varphi = \frac{\pi}{4}$ rad $T = 0,02\ s$)

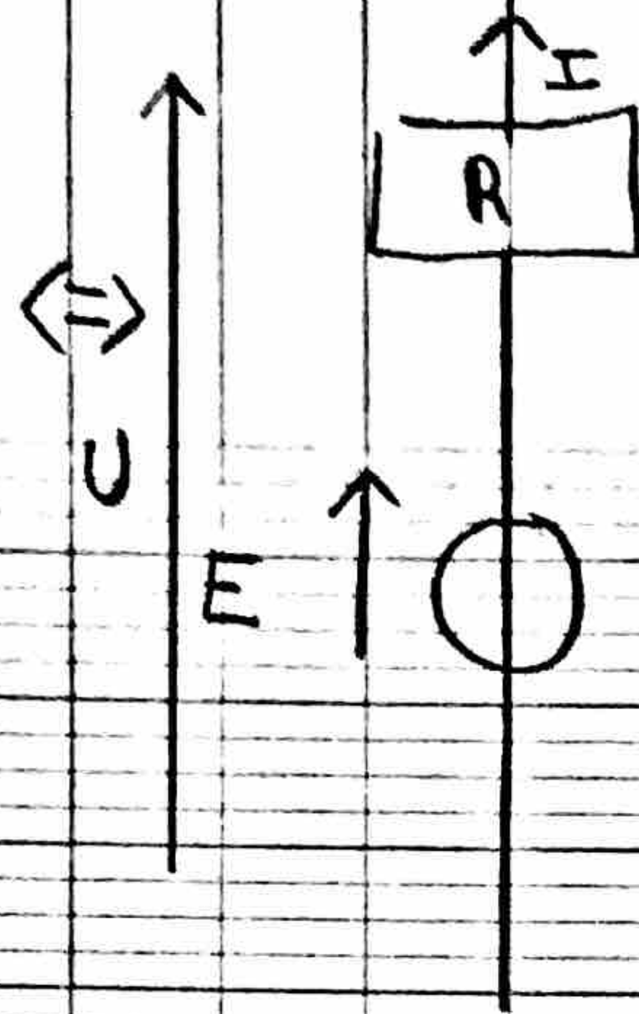
(5/9) **Assignment 1: "Zener diode"**

1)



with $R_T = \frac{R_1 R_2}{R_1 + R_2}$

$i_T = \frac{E_1}{R_1} - \frac{E_2}{R_2}$



2/2

$\Leftrightarrow$ with $\boxed{R = R_T = \frac{R_1 \times R_2}{R_1 + R_2}}$

and $E = E_T = i_T \times R_T$

$= \left(\frac{E_1}{R_1} - \frac{E_2}{R_2}\right) \times \frac{R_1 R_2}{R_1 + R_2}$

$$\boxed{E = \frac{E_1 R_2 - E_2 R_1}{R_1 + R_2}}$$

2) In Passive sign convention (PSC)

$U = E - RI$ (see figure above for conventions) Yes, thanks!

0.5 Hence $I = \frac{E}{R} - \frac{U}{R}$ since $E = 1{,}5V$ and $R = 50\,\Omega$

$I = 0{,}03 - \frac{U}{50}$ Hence the I-V curve of the generator and the resistor is a straight line.

When $U = 0\,V$ $I = 0{,}03\,A = 30\,mA$

$U = 1\,V$ $U = 0{,}01\,A = 10\,mA$

0.5 (Cf graph appendix).

0.5 We find $U = 0\,V$ and $I = 0{,}03\,A$ as operating point.

Less true since here the operating points are one we calculated. → Yes, you're right

The graphical method implies a lot of uncertainties especially since here the I-V curve of the diode is thinck ? Thick?

3) If now the terminal of the diode are switched we still have the same I-V curve for the generator and the resistor but the diode one is not the same anymore.

We know now that if $i < 0$ $u = 0$ Excellent!

and if $i > 0$ $u = 1$

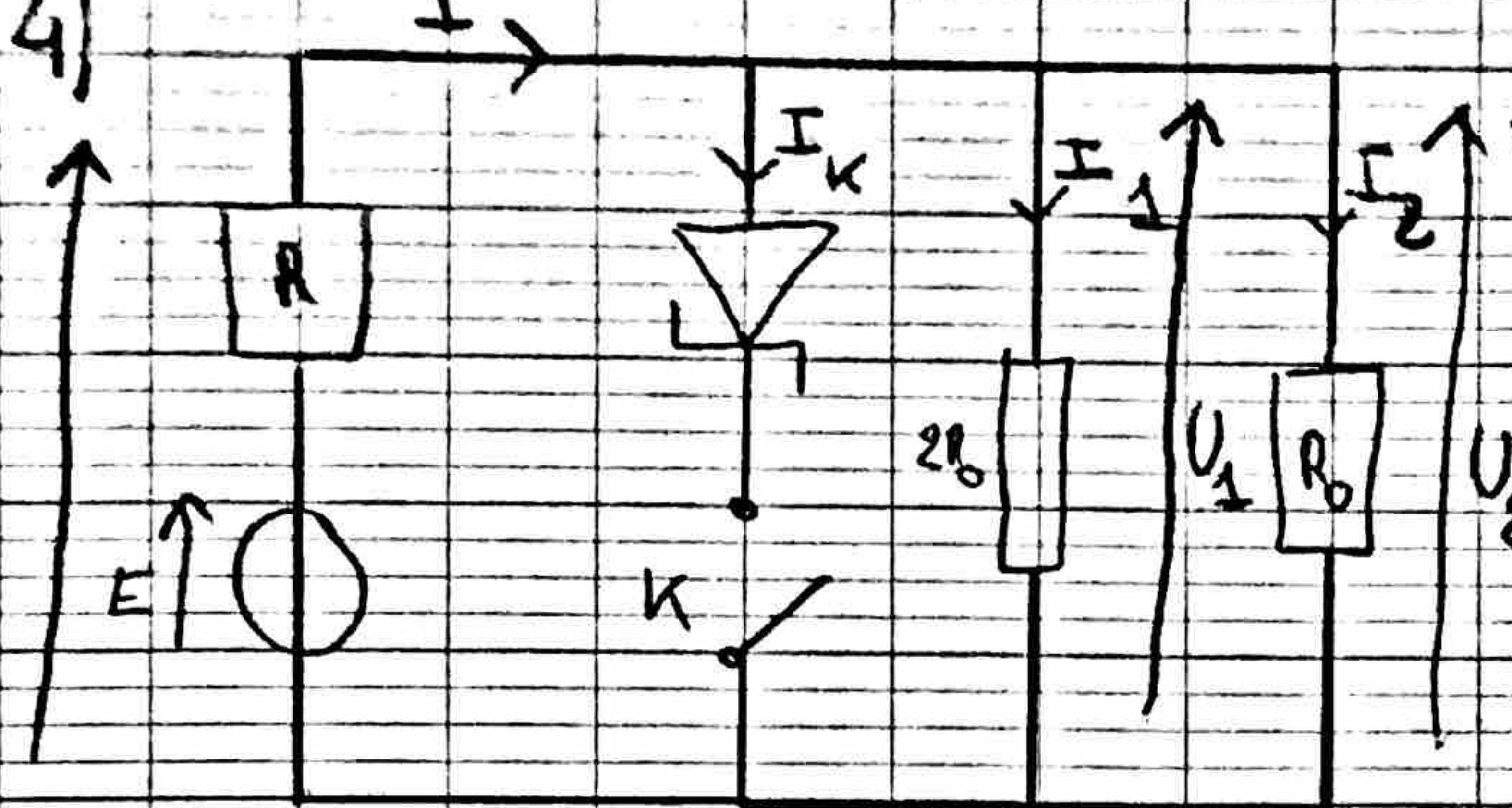
0.75 (Cf graph appendix 2).

0.25 The new operating points are $I = 10\,mA$ and $U = 1V$

(Once again, in this method the uncertainties are higher than with a direct calculus). Yes indeed.

BONUS: +0.25 Very good comments and justifications plus all conventions spec

4)



0.25

When K is open there is no intensity in the branch so $I_K = 0$

We can even remove it from the circuit.

Then thanks to Kirchhoff's current law (KCL) we know that $I = I_1 + I_2$ (1)

Moreover in PSC we know that $I = 0{,}03 - \frac{U}{50}$ (2)

Do not mix numerical values with litteral expression. Keep the latter one!

From Kirchhoff's voltage law (KVL) we have $U = U_1 = U_2$ (3)

and in PSC $U_1 = 2R_0 I_1$ (4) and $U_2 = R_0 I_2$ (5)

Since $U_1 = U_2$ (3) we have $2R_0 I_1 = R_0 I_2$ (4) & (5)

hence $I_1 = \frac{I_2}{R_0}$

Non homogeneous expression !!

From (1) we have $I = \frac{I_2}{R_0} + I_2 = \ldots$

Method question 4 and 5

I did not manage to finish those 2 questions because of time but the method is the same for both (except that for the 5th question we need to take i_K into account.

Yes so the method won't be the same at the end.

I first need to draw a scheme and define all the conventions.

Then thanks to KCL I can write the intensity in terms of other (I need 2 equat° for 4. and 3 for 5th question)

Not exactly.

Then with KVL I obtain other equation and I can then solve a system to find all the intensity.

Yes, this is indeed the method you should have used for this question 4.

ecified.

(2)

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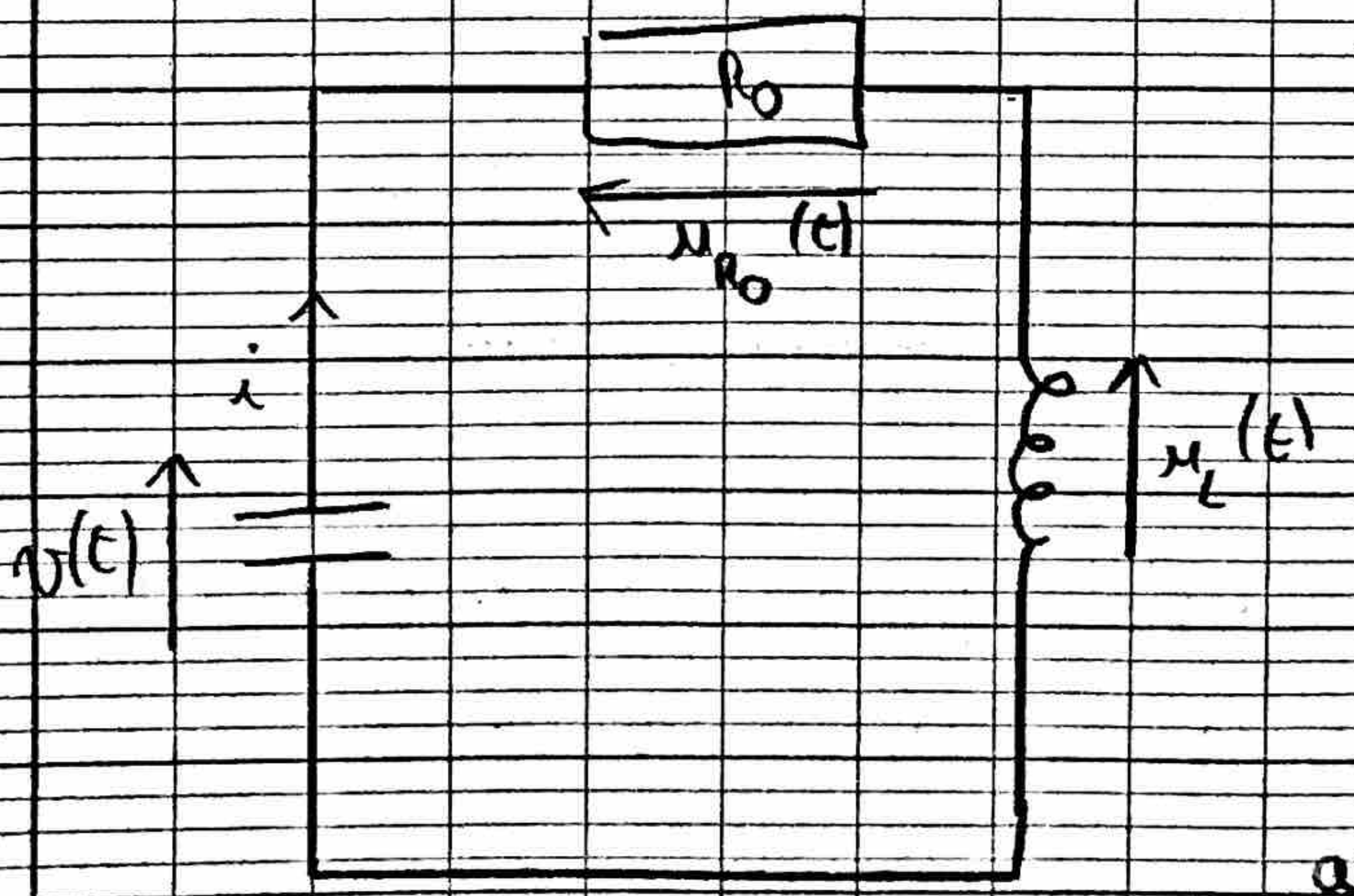
Assignment 2

1) For $t > 0$ we have this circuit (with the capacitor charged).



From KVL we have

0.5 $$v(t) = u_{R_0}(t) + u_L(t) \quad (1)$$

0.5 with $i(t) = -C\dfrac{dv}{dt}$ (2)

No here this is ASC!

0.25 and $u_L(t) = L\dfrac{di}{dt}$ (3)

0.25 and $u_{R_0} = i(t) \times R_0$ (4)

PSC

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2) From question 1 we have: from (1); (3); (4).

$$v(t) = i(t) \cdot R_0 + L \frac{di}{dt} \Leftrightarrow i(t) \cdot R_0 + L \frac{di}{dt} - v(t) = 0$$

0.5 then from (2): $-LC \frac{d^2v}{dt^2} - CR_0 \frac{dv}{dt} - v(t) = 0$

$$\Leftrightarrow LC \frac{d^2v}{dt^2} + CR_0 \frac{dv}{dt} + v(t) = 0 \quad *$$

0.5 $$\Leftrightarrow \frac{d^2v}{dt^2} + \frac{R_0}{L} \frac{dv}{dt} + \frac{1}{LC} v(t) = 0$$

$$\Leftrightarrow \frac{d^2v}{dt^2} + 2\delta \frac{dv}{dt} + \omega_0^2 v(t) = 0$$

0.5 with $\delta = \frac{R_0}{2L}$ and $\omega_0 = \frac{1}{\sqrt{LC}}$

dimension equation ≠ equation.

* This equation is Homogeneous because: ⚠

$T^2 \times \frac{[v]}{T^2} + T \times \frac{[v]}{T} + [v] \cancel{= 0}$ the reste is only changement of writting. yes

BONUS: +0.25

But the constant I find feels weird.

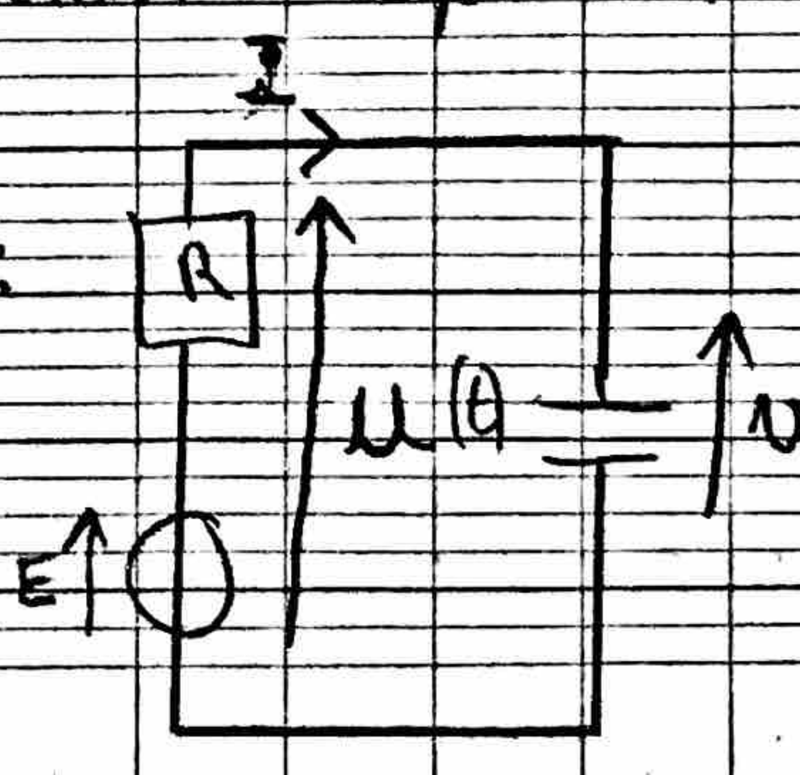
which constant ?

3) $v(t=0^+) = v(t=0^-) \overset{PSC}{=} u(t) = E - Ri(t)$ Yes

↳ voltage across a capacitor is constant as a function of time.

0.25

at time $t < 0$:



0.25 $i(t=0^+) = i(t=0^-) = 0$ since $u(t) = i(t)R$

↳ continuous fonction of time

we have $u(t=0^+) = u(t=0^-) = 0$

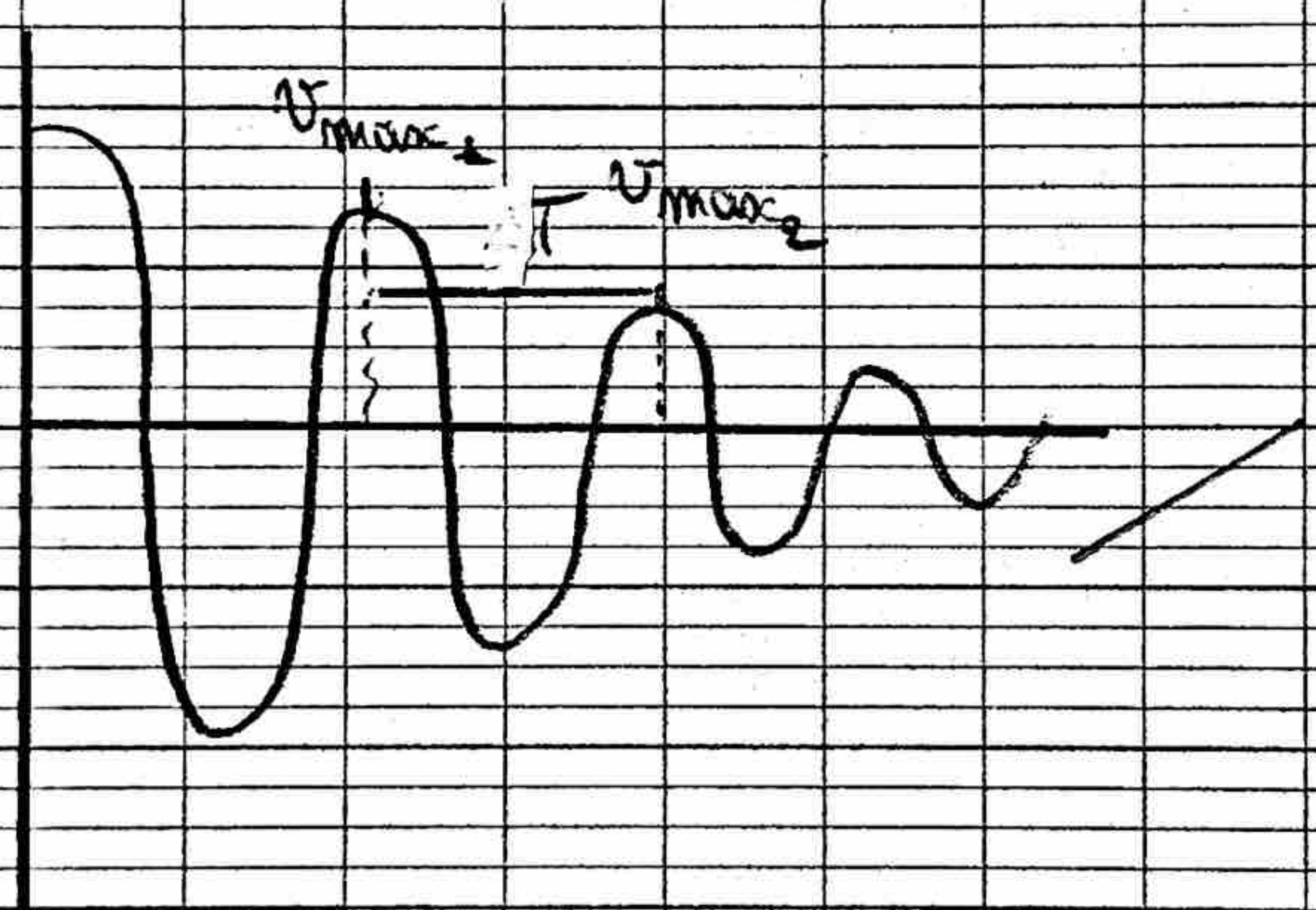
↳ continuous fonction of time

$u_L(t=0^+) = u_L(t=0^-) = 0$ ~~since~~ at $t<0$ switch was open.

↳ voltage accross a coil is a continuous fct of time

Noooo! For a coil, this is the intensity, which is a continuous function of t

4) We know that a pseudo period corresponds to T As shown below:



0.5 Graphically we obtained T = 70µs

But we have different sources of uncertainties (randoms and systematic):

→ uncertainties on the position of $v_{1,2}$ max (estimated at 2µs×2)

→ uncertaintie on the ruler (estimated at 1µs ×2)

Hence $\Delta T = 6\mu s$

0.5 Hence $T = ([illegible] \pm 6)\mu s$ (High uncertainty due to graphic method!)

5) Graphically A = ?

φ = ?

6) $T \approx \frac{2\pi}{\omega_0} \Leftrightarrow \omega_0 = \frac{2\pi}{T} = 8\,9759$ Unit ?

Never give a numerical result without its uncertainty.

We know from question 2) (if it is correct) that:

~~0.25~~ $\omega_0 = \frac{1}{\sqrt{LC}} \Leftrightarrow L = \frac{1}{\omega_0^2 \times C}$

0.25 (method) $L_{max} = \frac{1}{\omega^2 \times C_{min}} = \frac{1}{\omega^2 \times (C - \Delta C)} = 0{,}0137\ H$ X

this can also be min or max

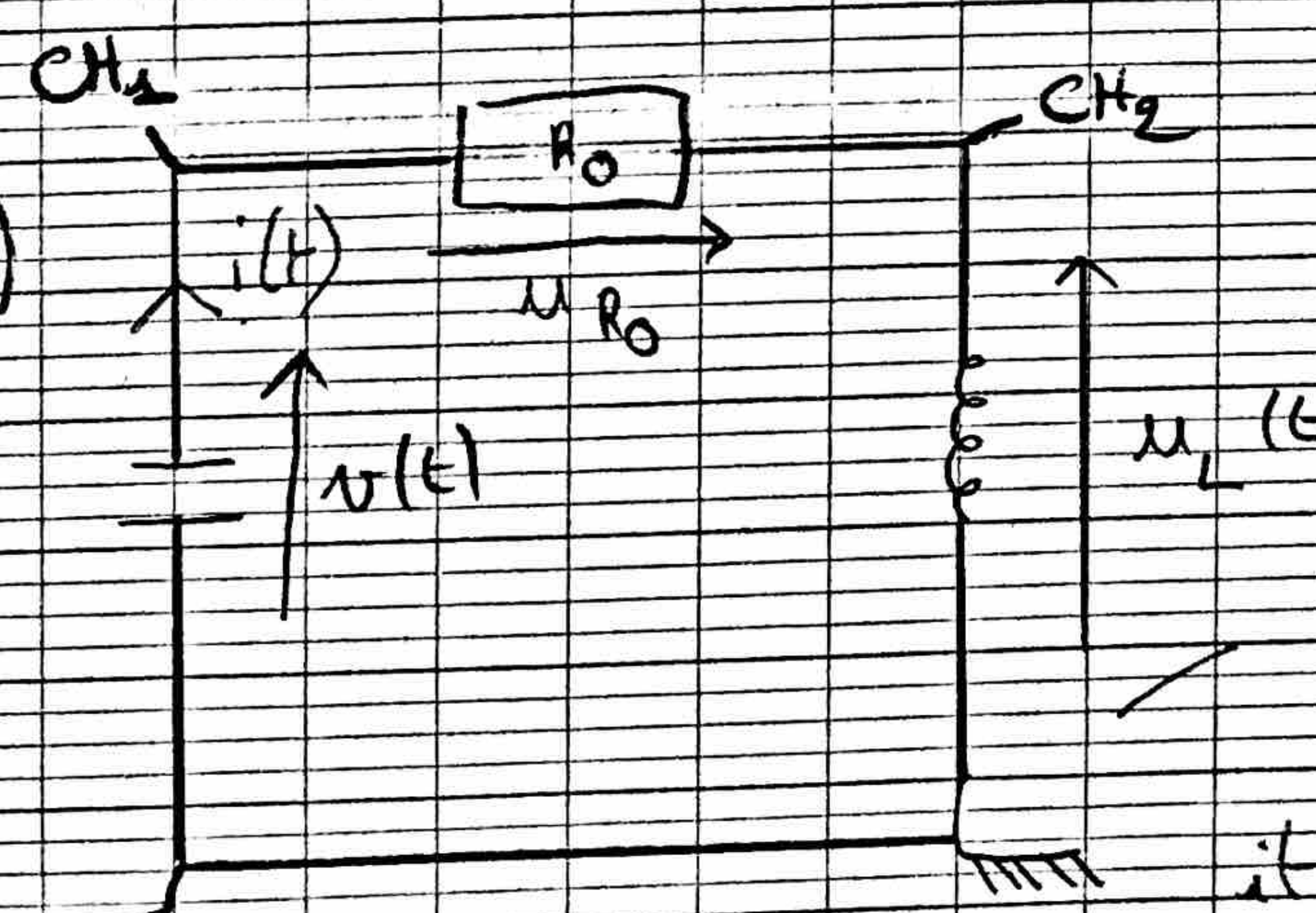
0.25/0.5 $L_{min} = \frac{1}{\omega^2 \times C_{max}} = \frac{1}{\omega^2 \times (C + \Delta C)} = 0{,}0113\ H$ X

$L = \frac{L_{max} + L_{min}}{2} = 0{,}0125$ Unit ?

$\Delta L = \left| \frac{L_{max} - L_{min}}{2} \right| = 1{,}2.10^{-3}$ Unit? (Uncertainty is a bit higher because the equation used at the beginning is not a perfect one)

0.25 $L = (11{,}3 \pm 1{,}2)\ mH$

7)



We can visualize v(t) directly in Channel 1.

As for i(t) we can visualize it through the maths function (careful at the scale used) by doing $CH_2 - CH_1$ we would obtain the signal corresponding to $u_{R_0} = i(t) R_0$. X

0.25/0.5

You have to do $CH_1 - CH_2$ to get $+ i R_0$!

⚠ ...

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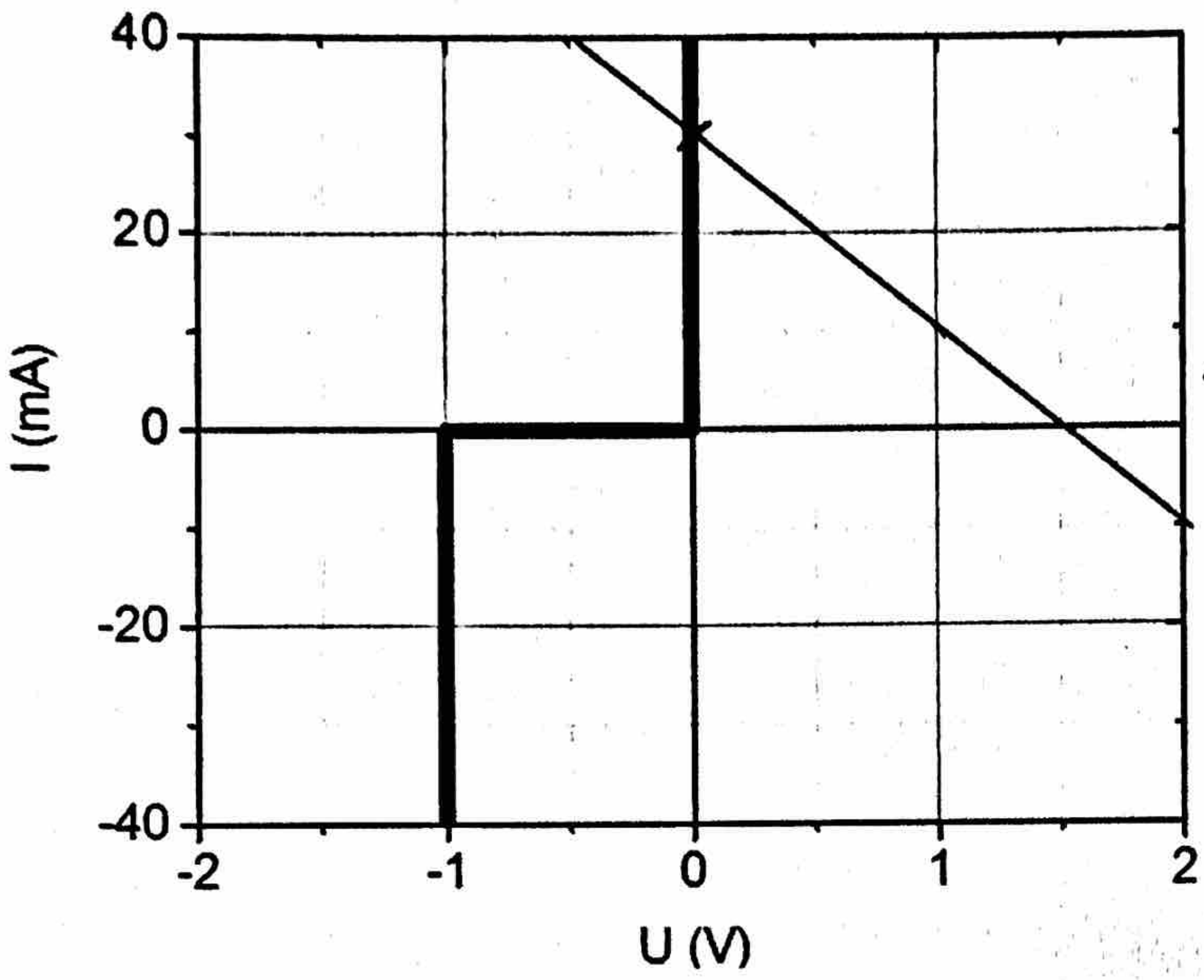
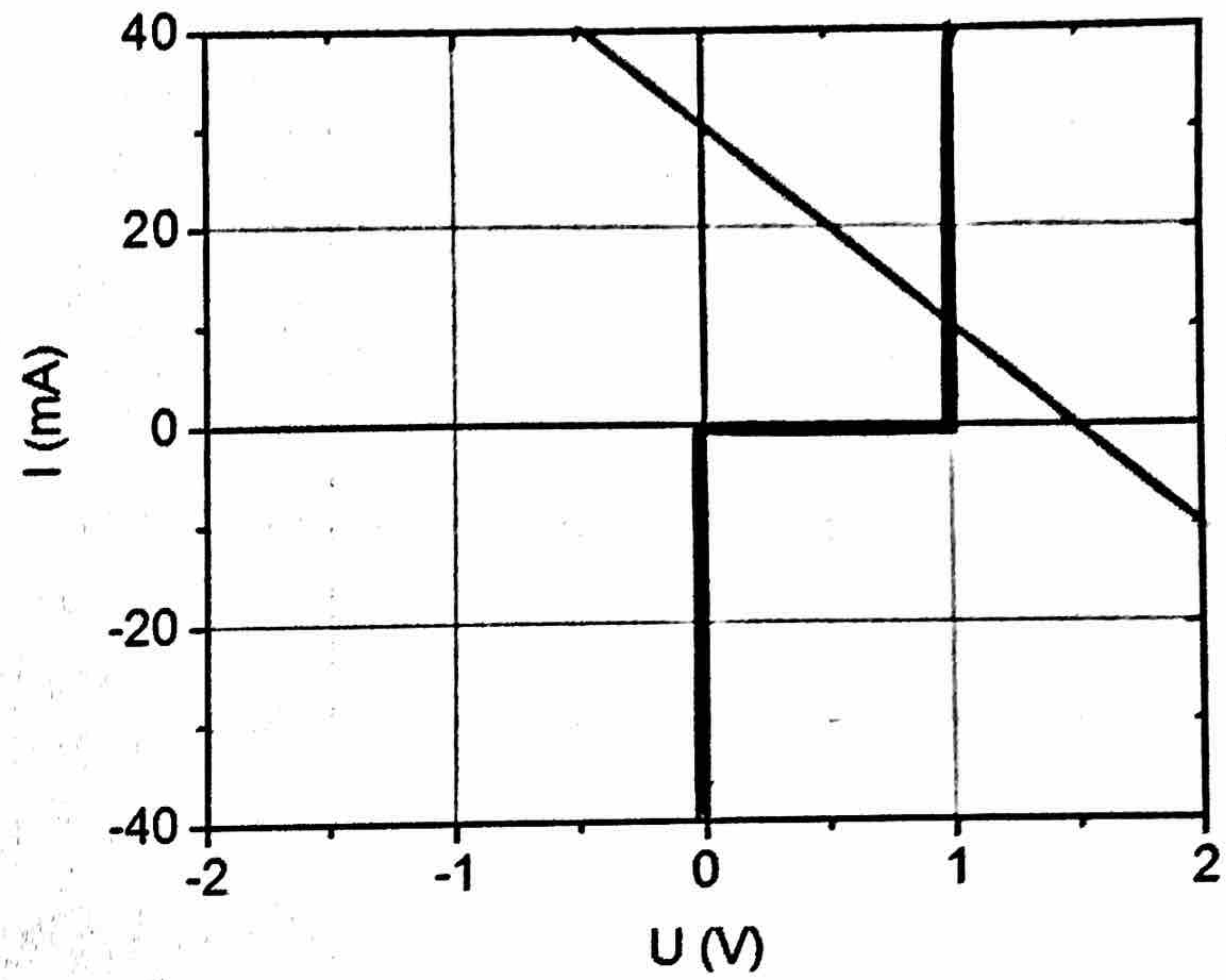
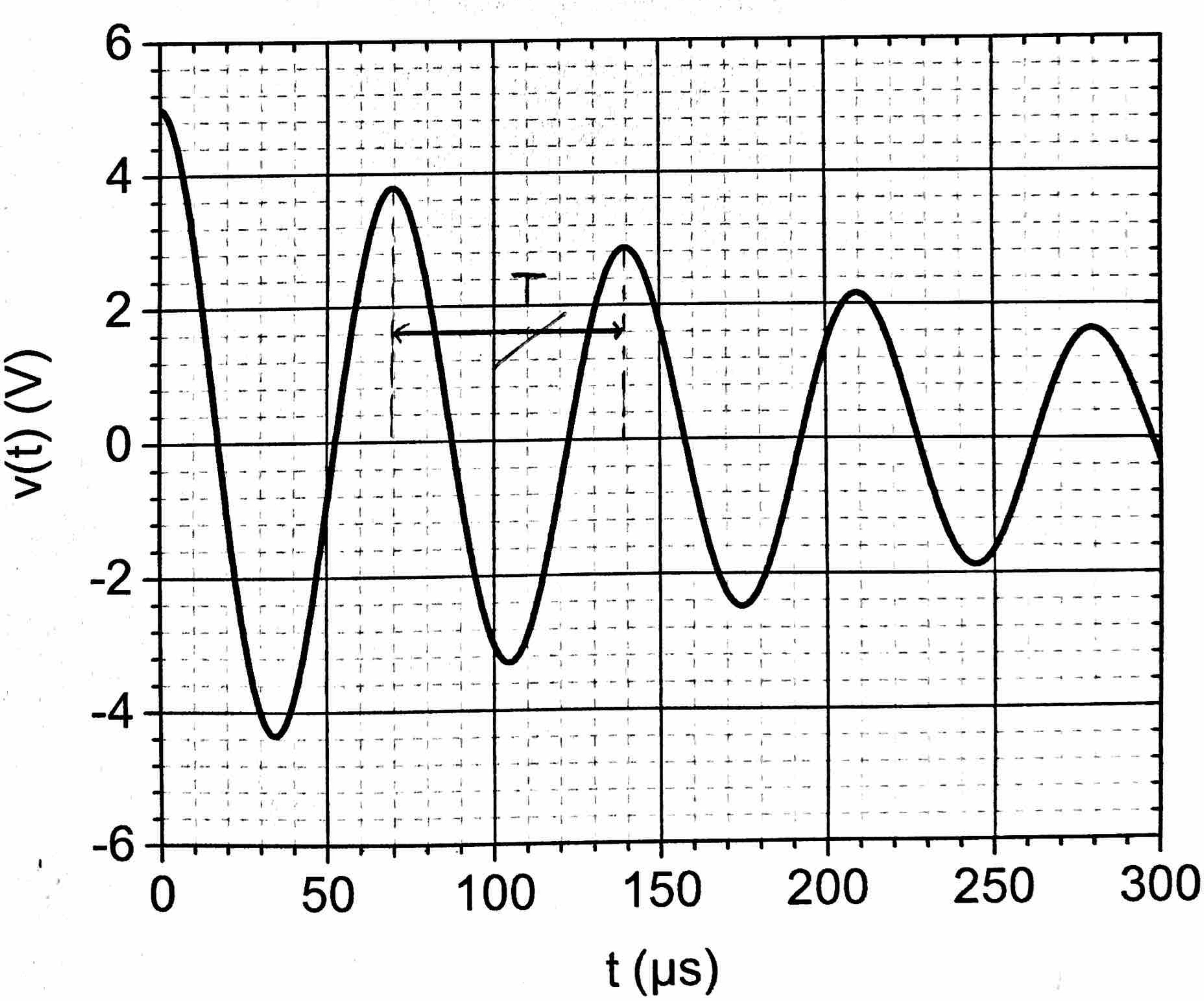


Appendix 1: *I-V curve of a Zener diode in passive sign convention*



Appendix 2



Appendix 3