EQUILIBRIUM in circuits with C e L

(jämvikt)

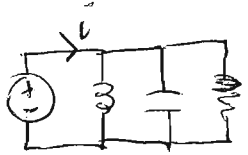
(and U, I, R and dependent source and opamp ...)

"the story so far" (since we introduced C e L) —

basics

Last time

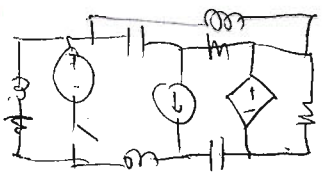
"conveniently" chosen circuits where we can solve currents or voltages quite independently, eg.



equilibrium and continuity

Now

Soon



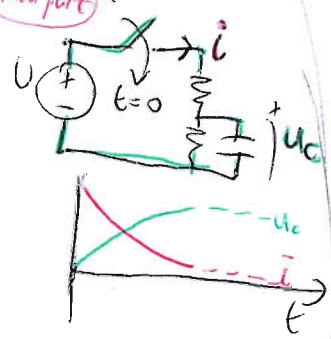
any circuit -- but --

Very limited situations

(just "after a long time" or "immediately after a change")

time functions

final part



Very limited circuits (else the equations are hard)

Basic principle of equilibrium:

If all sources are constant (dc)

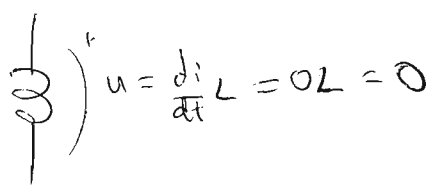
and we wait a long time

and the circuit is ~~realistic~~ stable (not constantly rising like  "ideal")

... then all u & i will settle to constant EQUILIBRIUM VALUES
jämviktsläge

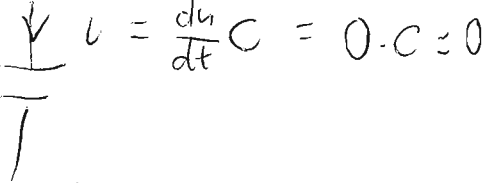
and this means $\frac{du}{dt} = 0$, $\frac{di}{dt} = 0$

which means



$u = \frac{di}{dt} L = 0 \cdot L = 0$

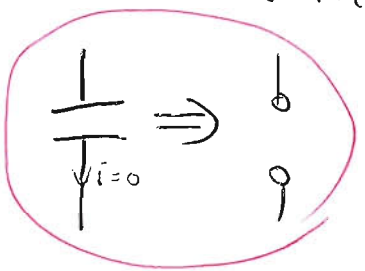
like a SHORT CIRCUIT



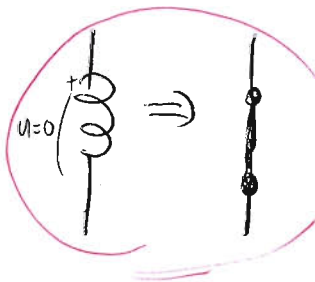
$i = \frac{du}{dt} C = 0 \cdot C = 0$

like an OPEN CIRCUIT

So: to find circuit quantities in the equilibrium state after all sources have been constant for a long time, we just replace

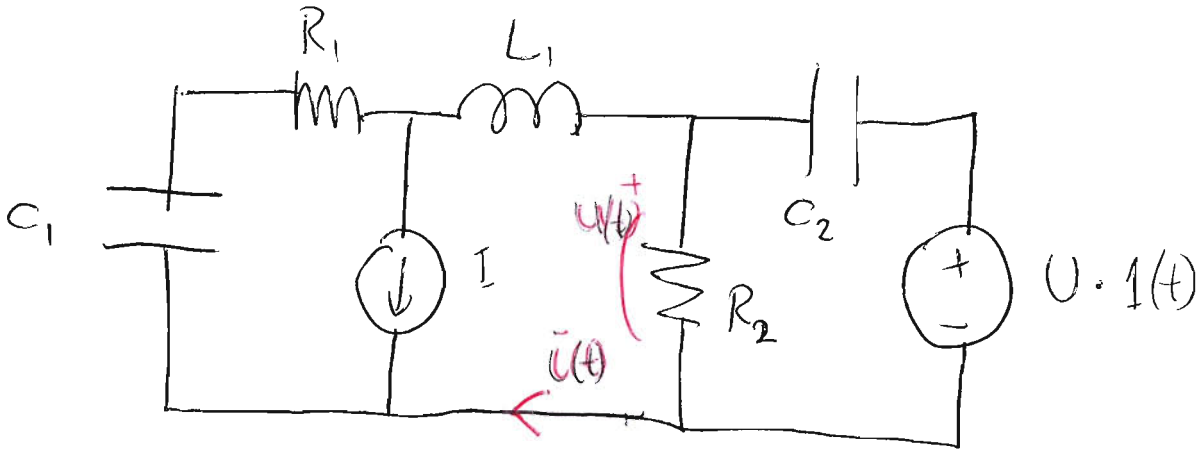


and



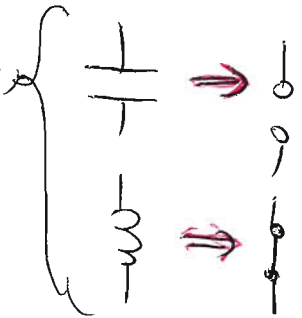
Actually quite easy!

A dc circuit



find $u(0^-)$, $i(0^-)$ } "0^-" means the time just before 0, (eller en sysgasjon) and 0^+ is just after.

$u(\infty)$, $i(\infty)$ } i.e a long time after the change av $U \cdot 1(t)$

When $t = 0^-$ we assume equilibrium (no change has happened at earlier times) ... therefore 

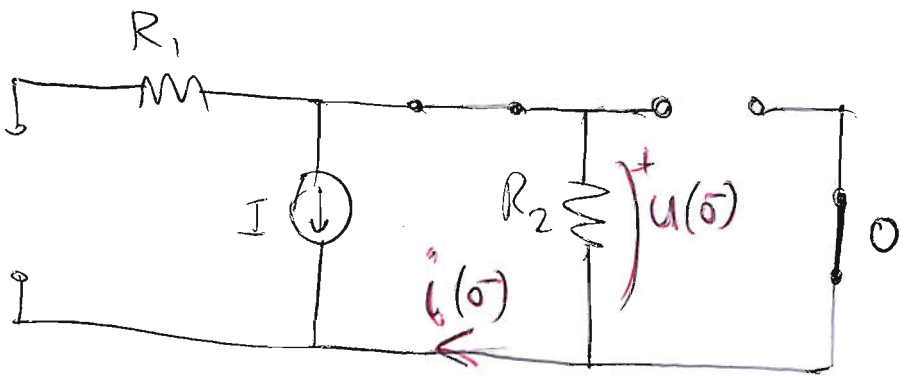
We can also state that $U \cdot 1(0^-) = 0$

We redraw with just the relevant information at this time.

$t = 0^-$

$i(0^-) = -I$

$u(0^-) = -IR_2$

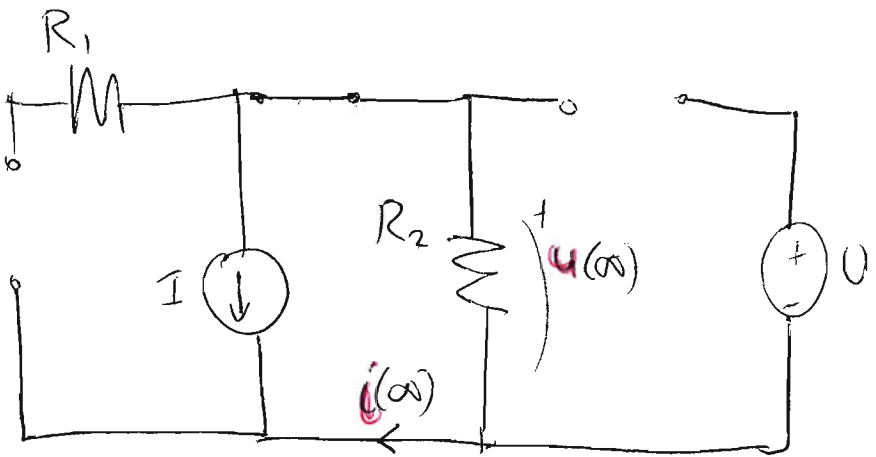


When $t \to \infty$ we get the same result: the voltage source is now U instead of 0; but it is 'isolated' by C_2 (which is open circuit in equilibrium)

$t \to \infty$

$i = -I$

$u = -IR_2$



And that's it! Equilibrium, finished.

It's a simple principle, involving an assumption (stable circuit) and using dc circuit skills.

It's needed as a starting point for the following topics:

- on CONTINUITY (es. $u(0^+)$ and $i(0^+)$ in our example)
- and TIME FUNCTIONS (to give an initial condition)

Many E and EM exams have a Q4 or Q5 with equilibrium (and continuity) situations.