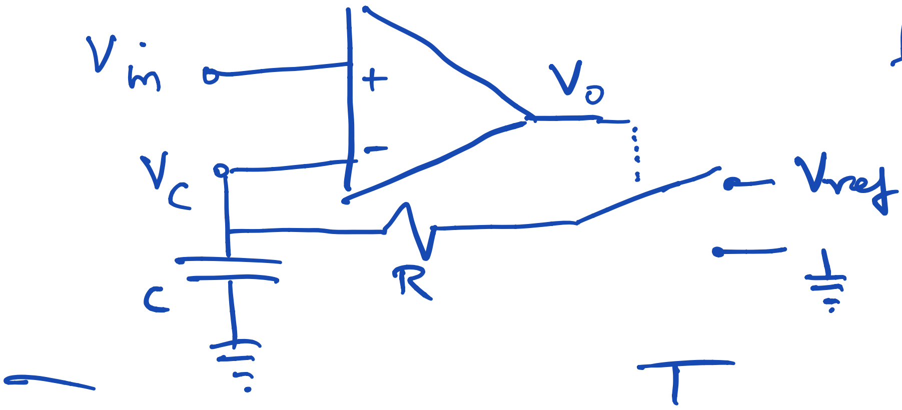
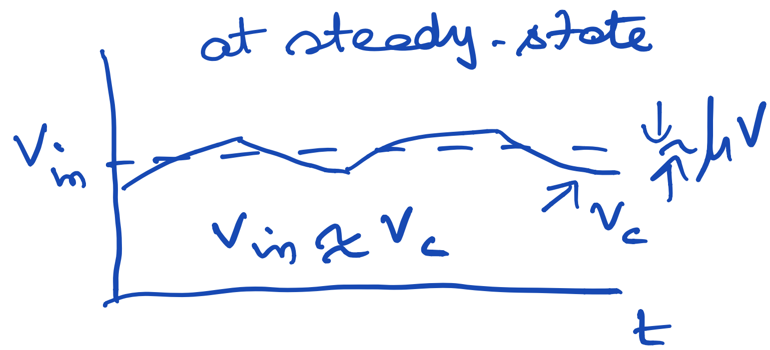
11.01.2019

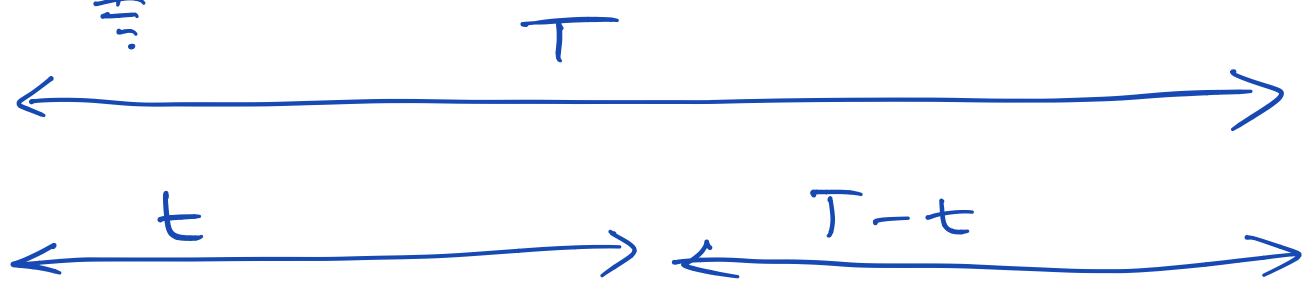
# ELL301

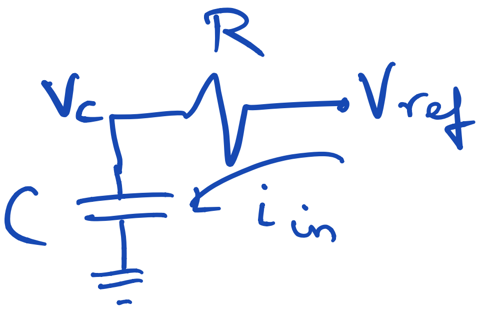


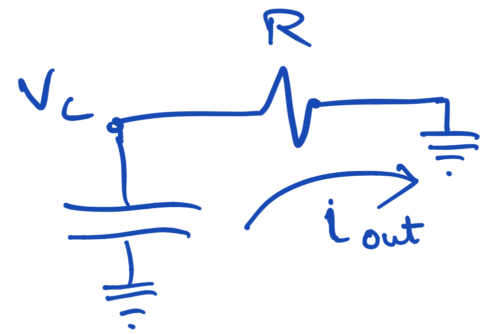

if $V_o$ is HI

if $V_o$ is LO




Claim: Measuring $\frac{t}{T}$, we should know $V_{in}$ relative to $V_{ref}$

Why?

How → $Q_{in} = Q_{out}$, at steady state → Q: charge

definition ↙ ↓ definition

$i_{in} = \frac{V_{ref}-V_c}{R}$ $\quad \int i_{in}\,dt \qquad\qquad \int i_{out}\,dt$ as $i_{out} = \frac{V_c}{R}$

$\int \frac{V_{ref}-V_c}{R}\,dt \qquad\qquad \int \frac{V_c}{R}\,dt$

Approximation

Approx

as $V_{in}$ Constant

$$\int \frac{V_{ref}-V_{in}}{R}\,dt \qquad\qquad \int \frac{V_{in}}{R}\,dt$$

based on $V_{in}$ & $V_c$

as $V_{in}$ constant

$$\frac{V_{ref}-V_{in}}{R}\,t \qquad\qquad \frac{V_{in}}{R}(T-t)$$

So, $$\left(\frac{V_{ref}-V_{in}}{\cancel{R}}\right)t = \frac{V_{in}}{\cancel{R}}(T-t)$$

$$\Rightarrow \frac{V_{ref}-V_{in}}{V_{in}} = \frac{T-t}{t}$$

$$\Rightarrow \frac{V_{ref}}{V_{in}} - \cancel{1} = \frac{T}{t} - \cancel{1}$$

$$\Rightarrow \frac{V_{in}}{V_{ref}} = \frac{t}{T}$$

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2 things left,

1. What if we don't make approximation?

2. How to use $\frac{V_{in}}{V_{ref}} = \frac{t}{T}$ to get digital version of $V_{in}$?

↳ Op. amp output