Electronic Instrumentation

Re-exam 17/02/2012

1] $R(t) = R_f + (R_i - R_f)\exp(-t/\tau)$

R_f = final value = 100 kΩ

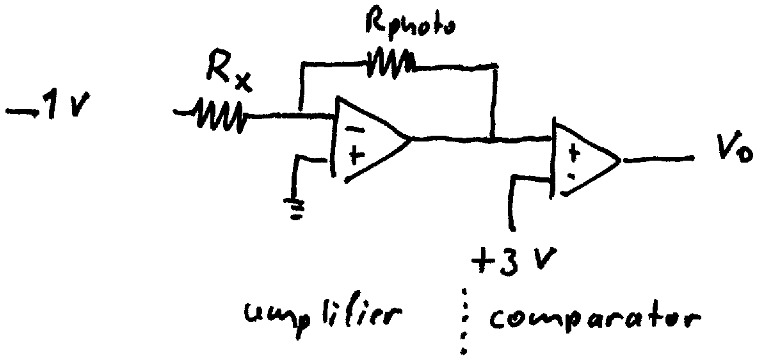
R_i = initial value = 30 kΩ

τ = 50 ms

$R(t) = 100\ k\Omega - 70\ k\Omega\ (-t/50\ ms)$

$R(10\ ms) = 42.69\ k\Omega$

Example

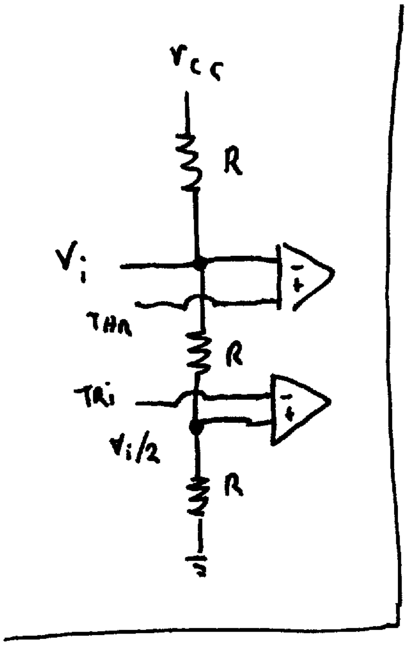


$$(-1\ V) \times \left(-\frac{R_{photo}}{R_x}\right) = +3\ V$$

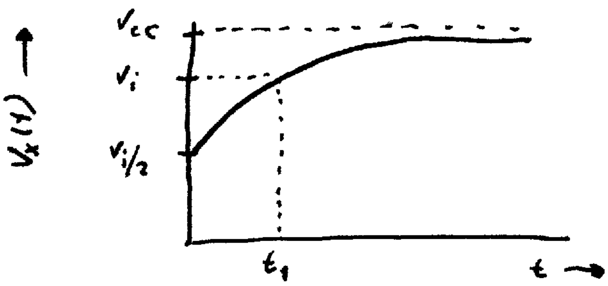
$R_{photo} = 42.69\ k\Omega \Rightarrow R_x = 14.2\ k\Omega$

2] See lecture notes

3] This circuit is very similar to the oscillator of our excercises, with one small differences: Instead of the control voltage of the top comparator being $\frac{2}{3}V_{cc}$ it is at V_i, and the other $\frac{1}{3}V_{cc} \rightarrow \frac{1}{2}V_i$. This makes the timing different. At the capacitor charging cycle it charges from $\frac{1}{2}V_i$



to V_i



$$V_x(t) = V_{cc} - (V_{cc} - V_i/2)\exp(-t/\tau_1)$$

$$\tau_1 = (R_1 + R_2)C$$

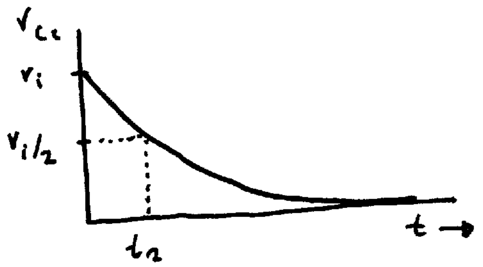
when V_x reaches V_i the system commutates

$$V_{cc} - (V_{cc} - \tfrac{V_i}{2})\exp(-t/\tau_1) = V_i$$

$$t_1 = \tau_1 \ln\left(\frac{V_{cc} - V_i/2}{V_{cc} - V_i}\right)$$

(note that we get $\tau_1 \ln(2)$ back for $V_i = 2/3\,V_{cc}$)

For the discharging cycle we have



$$V_x(t) = V_i \exp(-t/\tau_2)$$

$$\tau_2 = R_2 C$$

when V_x reaches $V_i/2$ the system commutates

$$V_i \exp(-t/\tau_2) = V_i/2$$

$$t_2 = \tau_2 \ln(2)$$

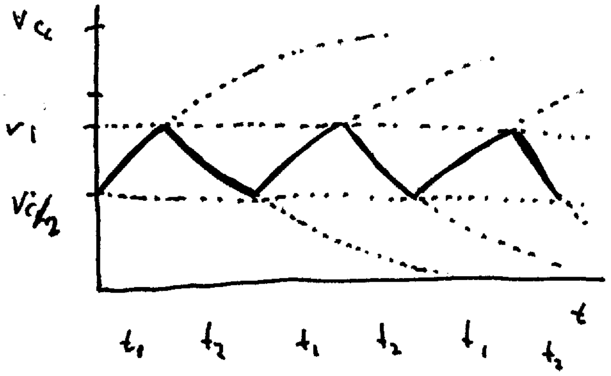
(note that this is equal to case for $V_i = 2/3\,V_{cc}$)

The total frequency is given by

$$f = \frac{1}{t_1 + t_2} = \frac{1}{\tau_1 \ln\left(\frac{V_{cc} - V_i/2}{V_{cc} - V_i}\right) + \tau_2 \ln(2)}$$

$$= \frac{1}{(R_1 + R_2)C \ln\left(\frac{V_{cc} - V_i/2}{V_{cc} - V_i}\right) + R_2 C \ln(2)}$$

The final figure



4] See lecture notes

5] a) See Lecture notes

$$B_z = \frac{1}{\mu} \frac{V_y d}{V_x h}$$

or

$$V_y = \frac{\mu B_z h V_x}{d}$$

b)
$\mu = 1500\ cm^2/Vs = 0.15\ m^2/Vs$
$h = 1\ cm$
$d = 1\ mm$
$V_x = 10\ V$
$B_z = 0.1\ T$

} $V_y = 1.5\ V$

c) $S = \frac{d V_y}{d B_z} = \frac{\mu h V_x}{d} = 15\ V/T$

d) 30 mT → 0.45 V → scale 2 volt → $\Delta V = 0.001\ V$

$$\Rightarrow \Delta B = \frac{\Delta V}{S} = \frac{1\ mV}{15\ V/T} = 67\ \mu T$$